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Caveman's Comfort

► THINK OF a cold, rainy night. Outside, the wind howls, the storm beats against the doorway. Inside, it is dry and warm. Everybody for whom you are responsible is safe. You have a cozy feeling of security. With a comfortable sensation of fullness from a recent meal, and a reasonable amount of certainty as to where your next meal is coming from, your standard of living has about reached its peak.

Yet there is nothing in that description to show whether the shelter is a palace, a cottage or a foxhole, whether "you" are a millionaire of the twentieth century or a Pleistocene caveman. In short, comfort derives from our fundamental need for food, clothing and shelter. Civilization adds nothing to the enjoyment the individual gets out of having these needs satisfied. What civilization accomplishes is the pooling of effort so that more people can reach the level of comfort enjoyed by the warm and well-fed savage and his family in their dry cave.

But the demand for dry caves long ago created the first housing shortage. When there weren't enough caves to go around, primitive geniuses had to invent artificial ones, and when building materials became scarce, new kinds of material had to be impressed into service and designs had to be altered to fit such material.

Wood and stone, brick and cement have played their part in the development of housing. Now the organic chemist's new skill puts together huge molecules of synthetic polymers to form materials easily flowed and molded into large sheets and curved pieces. Housing is about to enter the Plastic Age.

Plastics, which have the new quality of large, smooth surfaces with integral color, open a new field of design possibilities. These many now be exploited to the full, as may the quality of transparency, formerly limited by the brittleness of old-time glass. But it is neither material nor method of working it that

(Continued on inside back cover).

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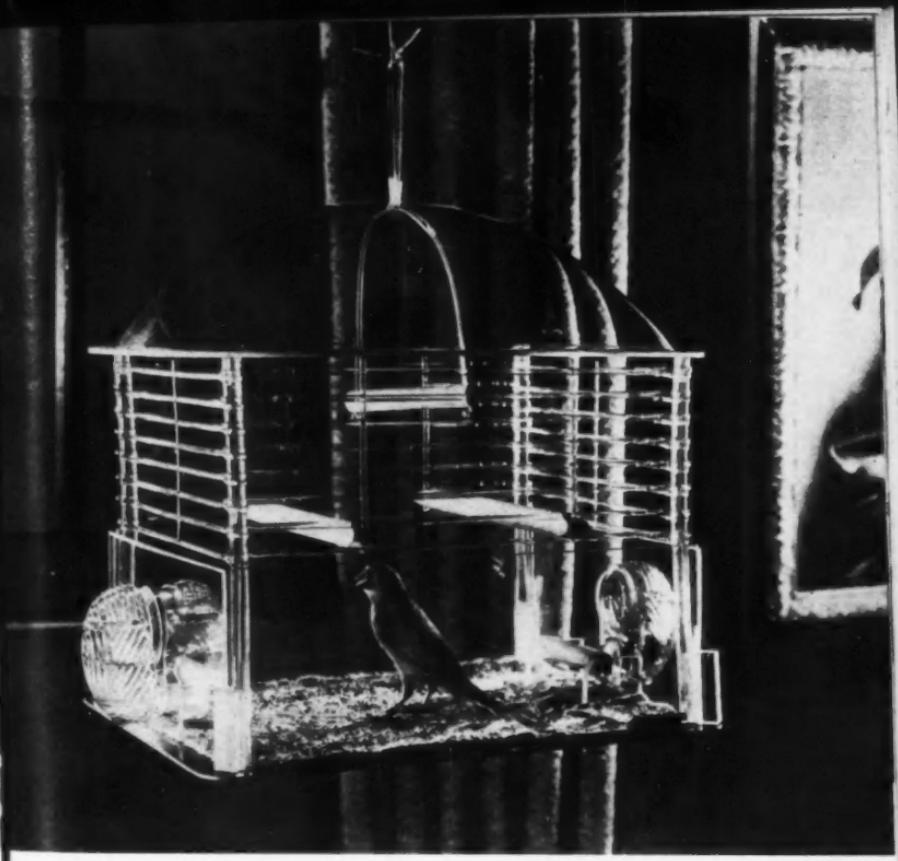
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—Photo courtesy Rohm and Haas Co.

► JUST A BIRD in a crystal cage! Gilded cages are out of date now that acrylic resins are plentiful enough, peace being here, to be used for something besides blisters on bombers. Plexiglas is the material used throughout. The bird has all-round vision, and that top bulge is a modern "bubble" top.

Plastics for Today's Housing

by DR. G. M. KLINE

Chief of Organic Plastics Section, National Bureau of Standards

► THE PLASTICS INDUSTRY has emerged from World War II with new materials and techniques destined to bear great significance in the building industry. These developments, pyramid-

ed upon the already imposing pre-war array, have added to the present and potential applications of plastics in the construction field generally, including homes, public buildings, and indus-

trial plants. The magnitude of the recent growth of the plastics industry, the applications now open to these materials in the building industry, and the advantages and limitations of plastics are important in evaluating their present and future role as basic materials.

The production of plastics expanded six-fold during the war period. In 1938 approximately 154,000,000 pounds were made; in 1945 this output had been boosted to 900,000,000 pounds. However, with all this growth the amount of plastics produced annually is still very small in comparison with that of other materials used by the building industry. This is clearly shown by the following tabulation of estimated production figures for 1946:

Cement	27,000,000 tons
Brick	9,000,000 tons
Building block	8,900,000 tons
Steel	6,000,000 tons
Lumber	4,900,000 tons
Rubber	900,000 tons
Plastics	500,000 tons

More important to the building trade is the significance of the low-pressure molding process developed during World War II. High-pressure machinery, high temperatures, and costly heavy steel molds were used in the mass production of the relatively small prewar plastic articles. The new low-pressure technique utilizes wood or concrete forms in place of the steel molds. Flexible rubber sheets or bags are forced into contact with the plastic by evacuation or mild air or steam pressure in an autoclave.

The factor that has made this reduction in pressure for molding possible is the development of resins

which will cure without giving off water. The high pressures heretofore used were required to prevent the water released during the molding operation from forming steam blisters in the finished product. The new resins, called polyesters, cure or harden by cross linking through unsaturated carbon-to-carbon bonds (polymerization) rather than by splitting out water (condensation).

This new technique has removed the size limitations which presses and steel molds had placed upon molded plastics applications. It has also made possible the economical production of small numbers of parts, the former insurmountable barrier to many potential users of plastics.

The low-pressure molding process was used during the war particularly for making radar housings. One of these was 8 ft. in diameter at the base and 8 ft. in height and was made in one piece from glass fabric impregnated with polyester resin. Another was a large dome about 34 ft. in diameter and 32 ft. high; this housing was made in 70 segments so that it could be transported by air. These structures begin to approach dimensions that are normally dealt with in the building industry.

Related to this new low-pressure technique is a method devised in the aircraft industry during the war for converting flat plastic laminated sheets into shaped parts. Many intricate machines have been devised by the aircraft trade to make metal sheets take the complex shapes required on airplanes. With this background of experience in handling sheet metals, it is not surprising that this same in-



—Photo courtesy National Bureau of Standards

► IT IS COLD inside, 70 degrees Fahrenheit below zero, enough to try the properties of the most versatile plastic. The scientist with his hands in what resembles an oven, is reaching into a miniature cold room, with hands protected with heavy woolen gloves. How much the specimens stretch under stress is measured.

dstry was the first successfully to apply sheet-forming methods to plastic laminates to produce a wide variety of aircraft parts.

Again, the important factors in the present and future uses of this post-forming technique are the ability to produce a few parts with negligible mold costs, the low pressures involved which make unnecessary costly invest-

ments in presses and auxiliary equipment, and the simplicity of the operation which is not dependent upon the use of skilled labor. The process consists essentially of subjecting the material to a temperature at which it becomes thermoplastic and quickly forming it over molds made of wood or other suitable materials. The surprising feature is, of course, the resid-

ual thermoplasticity retained by these thermosetting laminates which by definition were "infusible."

A war-stimulated development in composite structural products made by combining thin facing sheets of dense high-strength materials with low-density core materials is of direct interest to the building trade. This so-called sandwich construction was used in the famous speedy Mosquito bomber, in which plywood facing sheets were stabilized against bending or wrinkling by a core of the lightest wood available, tropical balsa.

The surfacing sheets, which add the necessary strength, abrasion resistance, and toughness to the sandwich, may be light metal alloys, resin-bonded plywood or laminated plastic sheets made of resin-treated paper, cotton cloth, or glass fabric. The core material may be an expanded or foamed resinous product similar to balsa wood in density and texture, or it may be a honeycomb structure made by impregnating paper or fabric with a resin, forming the impregnated product into a network of hexagonal cells, and curing the resin to maintain this cellular construction.

These sandwich materials should be of particular interest in the prefabrication field because their relatively light weight will make handling easier and transportation costs lower. They will also be available for the manufacture of lighter weight furniture and refrigerators, and airplanes, boats, railway cars, and other forms of transport.

Plastics are not always recognized as such in their functional roles in industry. For example, plywood is a

familiar structural material, but relatively few persons know that resin adhesives have transformed this old material into a versatile product adaptable to the methods and needs of modern industry. Casein was the common bonding agent for plywood in World War I and later years. However, this material is not resistant to alternate wetting and drying and is very susceptible to deterioration by mold growth. Hence, casein-bonded plywood is not satisfactory for exterior use. The introduction of phenolic resin as the adhesive resulted in a plywood bond which is weather and fungus resistant and meets the long-term requirements of the building industry.

The use of the resin bonding agent permits plywood to be bent by a steaming process into various curved shapes or, alternatively, the resin-coated veneers can be assembled over suitable forms and the desired shape permanently attained by setting the resin by means of heat. Speedy motor torpedo boats, bombers, trailers, railway cars, and tubular radio masts are among the larger structures which were built of resin-bonded plywood during World War II. This happy combination of resin and wood veneer has been referred to as the Renaissance of plywood. It has expanded tremendously the possible outlets for this relatively inexpensive structural material.

An improved type of synthetic resin for use in bonding assemblies of wood and other products on a construction job appeared during the war period. Prior to this time it had been necessary to use strong acids to cure the urea and phenolic adhesives used

for this purpose. These acids had a deteriorating action on the materials which were bonded. A resorcinol-formaldehyde resin is now available which cures rapidly at temperatures from 60° to 150° F under nearly neutral conditions. This type of resin adhesive has been found to be especially advantageous for bonding together timbers used in ship keels and in arches of large auditoriums or hangars.

Plastic laminates have found many applications in the interior decoration of public buildings, theaters, hotels, ships, and the like where the severe service requirements make the use of these higher cost materials economically practical. A laminated plastic is made up of a fibrous filler in sheet form, such as paper, linen, canvas, or glass fabric, and a resin binder. The sheets are impregnated with the resin and pressed together between steam-heated platens to give a hard dense product with a smooth, highly polished surface. Where a fireproof product is essential, a layer of asbestos or metal can be incorporated in the laminate.

The outstanding advantages which plastic laminates offer as building materials are superior physical properties, attractive decorative possibilities, ease of fabrication, and simplicity of application. The properties which have been of prime importance in the selection of these plastics by architects and builders are their unusual resistance to wear and to corrosion by moisture, acids, alcohols, alkalies, and other deteriorating agents, their excellent mechanical strength and their dimensional stability. Because of the homogeneity resulting from the method



—Photo courtesy National Bureau of Standards

► *A PLASTICS testing merry-go-round. Under the radiation of the ultraviolet lamp, the specimens undergo synthetic aging, being bathed in more-than-sunlight to be sure they will stand up in actual use. The circular tray of specimens is rotated to give each sample an even chance in the electric "sun."*

used in manufacturing them, the color of laminated plastics goes through to the subsurface layers and is, therefore, more permanent than a lacquered or varnished finish. The dense structure produced by the tremendous pressure is not readily penetrated by liquids spilled on the surface and hence the materials are not readily stained.

In addition to these superior physical properties the pleasing appearance which these materials possess is a decided asset. They are available in a practically unlimited range of colors, and the permissible choice of transparent, translucent, mottled or opaque finishes makes possible a variety of decorative effects. The surface texture and gloss can be varied at will,

and if desired a high polish can be obtained directly during the pressing operation. The surfaces are easily kept clean and fresh in appearance. The adaptability of the laminated plastic to inlay design enables the architect to relieve the drabness and monotonous sameness which has characterized the materials hitherto available for interior construction.

A factor which makes simplicity of installation is the fact that only one craftsman is required, a carpenter, instead of having to depend upon the concerted action of the various workmen involved in lathing, plastering, woodwork trimming, papering, painting, tile-setting, and so forth. In the event that prefabrication is not fully utilized, the desired shapes of laminated plastics can be readily prepared on the job with the carpenter's usual equipment.

Most of the applications of laminated plastics today can be attributed to the smart atmosphere which they create as well as to their properties which for many purposes make them the natural choice. They are relatively expensive and, therefore, find their principal use in business construction where their ruggedness is a decided asset. They were early recognized as an ideal material for table, counter, and bar tops, and have been installed in many restaurants, bars, cocktail lounges, and fountains. Their noise-deadening, resistance to staining, and warmth or low thermal conductivity characteristics are decided advantages in such applications. The fact that they can be obtained in a form in which they are resistant to blistering or scarring by cigarettes has resulted in their use as dresser, radiator, and

desk tops and window sills in hotels and ships staterooms. Another equally important application is as wall and ceiling panelling. Many theaters, hotels, and banks have used this method to modernize their lobbies. The variegated designs that can be obtained by the use of metal inlays have been utilized in night clubs and taverns. The laminated plastic is especially adapted to bathroom and kitchen walls, where the condensation of moisture from steam constitutes a severe deteriorating condition. The nonporous nature of the material, its resistance to attack by cleansing agents, and the minimum number of joints required permit the ready maintenance of the degree of cleanliness and sanitation necessary in these locations.

The use of laminated plastics for doors is particularly advantageous because of the happy combination of beauty and permanence which is achieved. Theaters, department stores, and railroads have specified this material for their entrances. Many elevator installations are made with laminated plastic for the doors as well as the cab interior and panelling immediately adjacent to the entrances. Fingerprints and other stains and smudges which ordinarily result from constant handling do not show up on its smooth, polished surface. Kick plates and push plates can be obtained in the same material. Where regulations require fire-proof construction, laminated plastic sheets cemented on metal doors provide a practical means of obtaining safety without limiting the architect in choice of color or design on the face of the door.

There are numerous non-structural



► THE WORLD'S LARGEST transparent plastic bubble is made of Plexiglas, by Rohm & Haas, designed by Edward H. Burdick Associates, formed by E. L. Cournand Co. in a specially-built vacuum tank, shipped over a special route (R. R. unspecified) from New York to Detroit to be used in a Ford Motor Co. advertisement. The picture was sent in by Newell-Emmett Co. public relations experts. But to us the high point of the whole affair is that in this picture a beautiful girl in a lovely pose is actually portrayed doing a useful job. We think it hits a new high in advertising!

uses of plastics in the building field. Handles for doors and faucets are molded of urea and melamine compounds. Toilet seats are very generally made by covering a wood core with a cellulosic plastic. The electrical industry is using vinyl resins and other synthetic polymers as insulation on wiring because of their greater resistance to aging, abrasion, and burning compared to rubber. Many plastic parts are found in the electrical switches and connections, cover plates, thermostat housings, and the like. Thermoplastic resins bind asbestos and pigments together to make flooring tiles.

Screening for windows and doors made of extruded filaments of polyvinylidene chloride is now available on the market. This non-staining plastic screening was found during the war to resist the severe corrosive conditions encountered in the tropics. Transparent plastics are not yet suitable for use in windows of buildings because of their relatively poor resistance to scratching. However, it is significant that revision of the ASA safety code for glazing automotive vehicles to permit the use of transparent plastics in the side and rear windows of busses, trucks, taxicabs, etc. is under consideration. For the severe service conditions encountered by these vehicles, the greater toughness and ready formability of the cast resin sheets, which were in general use during the war as windshields on military aircraft, offset the possible replacement problem due to scratching.

In the decorative field there are many potential applications of plastics in addition to those of the laminates already discussed. Resin-coated fab-

rics are available for use as wall and ceiling coverings. Vinyl films are entering the home as upholstery, shower curtains, and draperies. Synthetic resins and cellulose derivatives are used in the manufacture of protective coatings for interior decoration. It should be noted that these raw materials have been used in coatings for many years and that "plastic paints" are not a recent development. However, there has been some tendency recently to apply this term indiscriminately to all types of coatings, including oil and oleoresinous paints. It has been suggested that the designation "plastic paint" be restricted to those coating materials of which at least 75 per cent of the solids consists of a cellulose derivative, such as cellulose nitrate or ethyl cellulose, or a synthetic resin, such as an alkyd, vinyl, or phenolic resin.

A survey of new plastics introduced in this country during the war period listed 11 major additions. This is just an indication of the inevitable increase in the plastics population during the coming years. Admittedly this is a terrific headache for the large manufacturer who wishes to concentrate on mass production of one or two materials in order to decrease costs and thus expand the markets for plastics. However, the inherent versatility in plastic materials and fabrication methods does provide plenty of opportunity for the small business man with imagination to build a better product with plastics.

In order to enable the buyer to know that he is getting an article which will meet the requirements of the application, there is a program under way at the National Bureau of Standards to cooperate in setting up

consumer standards for various plastic products. For example, if plastic tiles are to be used in locations where they will be exposed to steam or hot water, the consumer standard would include a specification and test to insure dimensional stability under such conditions. The label on the product would then inform the public regarding the qualifications or limitations of the material, as established by such consumer standards. This is an important advance in the merchandising of products made from materials as complex and changeable as plastics.

The theme of the 1946 National Ex-

position of the Society of the Plastics Industry was "Plastics Make a Better World." One of the greatest problems of the industry is to bring home to the public through the press and platform that, like metals, there are many types of plastics and that selection of the right plastic for a particular job is very important. This concluding thought can be tied in with current developments in the use of plastics in the building field by a slight rearrangement and addition to the Exposition theme: "Better Plastics Make a World of Difference."

House Heat From Powdered Coal

►A NEW adventure in house heating is to be given a commercial trial. It is a system that uses for fuel very finely pulverized bituminous coal, the material developed for use in the new coal-burning gas turbine engines.

The test of the commercial practicability of this type of powdered coal for automatic home heating is to be made by William B. Rogers of Baltimore, Md. He has now organized a company which will erect a suitable plant for pulverizing bituminous slack in quantity.

The heating plan does not include the sale of the powdered coal, however. It proposes the sale of heat, on an annual heating service contract. The householder simply sets thermostatic controls in his rooms similar to those used to control oil and gas burners.

The necessary furnaces and their operation will be a function of the operating company. After installation

of the heating unit, the company will do all maintenance and servicing. The pulverized coal will be delivered as needed by tank service, as with oil, and run into the building through hose. The powdery ash resulting from combustion will be taken away by the fuel delivery truck.

For burning the pulverized coal, there is a special furnace, although some old furnaces can be converted, it is claimed. The house-size special furnace is a vertical sheet metal cylinder lined with refractory material. Top-mounting of the powdered coal burner provides for down-firing, after ignition by a gas pilot and sparkplug. A screw conveyor at the bottom of the airtight hopper brings the fluffy black dust to the blower for carburetion into the air stream going into the burner. A small take-off line from the blower sends additional air into the flaming chamber for more complete combustion.

Radioactive Isotopes Claim Places Reserved for Undiscovered Elements

Filling the Periodic Table

► THREE OF THE four still unnamed chemical elements have just been christened.

The new names are *technetium* for element atomic number 43, *astatine* for element 85 and *francium* for element 87.

The discoverers of the elements have done the naming as is the custom in chemical circles. Technetium with Tc as its symbol was the first artificially made element, formed by neutron or deuteron bombardment of molybdenum in 1937 in the 37-inch cyclotron at the University of California. Dr. C. Perrier, now at the University of Genoa, Italy, and Dr. E. Segre of the University of California have now named it after the Greek word for "artificial." Later when the fission of uranium was accomplished it was discovered that one of the fission products is element 43 and relatively large amounts have been isolated as a by-product of atomic bomb research.

Element 85, now called astatine with At as its code name, in 1940 was also born in a cyclotron, a larger 60-inch one also at the University of California. It is one of the chemical group of halogens, to which chlorine, bromine and iodine belong. So the co-discoverers, Dr. Segre, Dr. D. R. Corson, now at Cornell, and Dr. K. R. Mackenzie, now of the University of British Columbia, named it from the Greek for "unstable" since it is the only halogen without stable isotopes or varieties. Astatine is made by bom-

barding bismuth with alpha particles.

Actinium K is the name previously given to element 87 by its discoverer, Mlle. M. Perey, who announced her new element in 1939. Now she christens it francium, symbol Fr, after her country, just as Mme. Curie named the first element she discovered, polonium, after her native Poland.

This rash of new chemical element names announced in the British journal, *Nature*, results from the suggestion of Prof. F. A. Paneth of the University of Durham that missing elements positively found should be christened so as to clear up the periodic table of the elements.

Only element 61, which was discovered in the fission products of the atomic pile, now lacks a name. Its discoverers are a group of more than a half dozen scientists led by Prof. Charles D. Coryell, now at Massachusetts Institute of Technology.

Chemical books and tables will in many cases show elements 43, 61, 85 and 87 as previously discovered and named as masurium, illinium, alabamine, and virginium. But the researches culminated in the newer names for three of these elements are being accepted as the real discoveries of the elements for these places.

Four elements actually discovered since the ones now named are 93, neptunium; 94, plutonium, one of the two atomic bomb elements; 95, americium; and 96, curium, all made from uranium.

Making the Missing Elements

THE MAKING OF THE MISSING CHEMICAL ELEMENTS, by Prof. F. A. Paneth, Radiochemical Laboratory, University of Durham. Substance of a lecture delivered before the Royal Institute of Chemistry in Leeds on October 29, 1946. Reprinted from the Jan. 4, 1947 issue of *Nature*.

► ALMOST five years ago, in a lecture to the Institute of Chemistry in London, the success that radioactive methods had achieved in the task of completing the Periodic System was described. In the table given, the place of element 87 was filled by the symbol of a newly discovered branch product in the actinium series; but in the places of elements 43, 61, 85 and 93 no symbols were inserted, although, as explained in some detail, atoms of all these four elements had been artificially produced.

This denial of full citizenship to artificial elements seemed justified in those days. They had been produced in invisible amounts only, and they were unstable and usually not present on the earth; whereas in the case of all the natural elements, we could be sure that, even if they belonged to the radioactive families and were only represented by fairly short-lived isotopes, very considerable quantities always existed. (For example, the laws of radioactive equilibrium ensure the presence in the upper 60 km. of the earth's crust of more than 10,000 tons of polonium.) The limited importance attributed until a few years ago to the artificially produced elements was reflected also by the absence of any names suggested for them.

To-day the situation is very different. In the 1942 lecture the cyclotron was called "the most efficient instrument for atomic transmutation." Now this title goes to the uranium pile, with its largely superior output of neutrons. With its help many pounds of an artificial element with atomic number 94 have been produced which, on account of its half-life of more than 20,000 years, will be present on the earth for a long time to come. (For theoretical reasons we must expect a minute proportion of element 94 always to accompany natural uranium.) Although its manufacture was difficult, it would be a harder problem still to destroy the element; even if exploded as a bomb, only a fraction of the material comes to a premature end. Moreover, the availability of any desired quantity of element 94 opens the way to the production of visible amounts of elements still higher in the Periodic System. Finally, the uranium pile has given us the means of creating lighter elements in bulk too; among the very products of uranium fission are many new isotopes not only of well-known elements, but also of the missing elements 43 and 61, which can thus be obtained in a far greater quantity than by any previous method. The chemistry of some of the newly created elements is already known as well as, or better than, that of some of the less important ones which were discovered in Nature many decades ago, and their practical application is at least a possibility.

In these circumstances, there seems to be no doubt that the time has come

for the systematizing chemist no longer to discriminate between natural and artificial elements, but to pay equal attention to the study of both and, in the tables of the Periodic System, to insert everywhere the appropriate symbols. In this latter attempt we are, however, confronted with the difficulty that there is at the moment no complete agreement about the relative merits of the various claims to the discovery, or manufacture, of new elements. It is to be hoped that this question will be carefully discussed at some future meeting of a committee invested with international authority; pending that, I can give merely my personal views. However, an exchange of letters with several scientific workers interested in these questions has convinced me that most of them have come to the same, or very similar, conclusions.

In accepting names and symbols for the elements 43, 61, 85, 87, 93, 94, 95 and 96, I think chemists ought to be guided by the following rules. (1) The right to name an element should go to the first to give definite proof of the existence of one of its isotopes. (2) In deciding the priority of the discovery, there should be no discrimination between naturally occurring and artificially produced isotopes. (3) If a claim to such a discovery has been accepted in the past, but is refuted by later research, the name given should be deleted and replaced by one chosen by the real discoverer.

To state the last rule in so many words would seem unnecessary, if it were not that in at least two cases the general practice violates it. The names 'masurium' and 'illinium' are so firmly rooted in text-books and tables that

recent work on artificial isotopes of the elements 43 and 61 is sometimes referred to as the production of species of masurium and illinium, while the artificial isotopes actually were the first representatives of the hitherto missing chemical elements. Without going into details of the alleged discoveries, it seems necessary to say that the slowness of chemists in taking the obvious action of abandoning the suggested names is due to the failure of the claimants to withdraw their statements, although during years of intensive effort they had been unable to substantiate them. In the case of masurium, W. Noddack even went so far, five years after the announcement of the discovery, as to complain to the convener of a chemical meeting in Königsberg for not having invited him to speak on this element, as the geographical neighbourhood of Masuren would have made this specially appropriate and he would have been in a position to disclose the whole chemistry of masurium; but no communication has ever appeared on this work. During the War, W. Noddack was appointed professor of inorganic chemistry in Strasbourg by the occupying power; when in 1945 the French chemists returned, they found the symbol Ma painted on the wall of the main chemistry lecture theatre in a large representation of the Periodic System. (Private communication from Dr. J. Guéron.)

Actually, element 43 was first produced by Perrier and Segrè in 1937 by bombarding in the cyclotron element 42, molybdenum, with deuterons or with neutrons. This work was extended by Seaborg and Segrè. Further details may be found in my lecture of

1942. As to element 61, I mentioned in that lecture the work of two research teams, Law, Kurbatov, Pool and Quill at Ohio State University, and Wu and Segré at the University of California. It is most probable that both had isotopes of element 61 under investigation; but the difficulties of ascribing the various, not very strong, activities to definite atomic species were very great in those days, when cyclotron bombardment was the only means of producing them.

Now we are able to direct attention to an investigation on element 61 during the War by research workers engaged in the study of the radioactive fission products of the uranium pile. Speaking last April on the occasion of a symposium on nuclear chemistry at Atlantic City (New Jersey), Prof. Charles D. Coryell, of the Massachusetts Institute of Technology, then at the Clinton Laboratories, Oak Ridge, Tennessee, revealed that among the many scientifically important results obtained by workers on the project—he mentioned in this connection especially N. E. Ballou, L. E. Glendenin, J. A. Marinsky, E. R. Tompkins and G. W. Parker—was the clear identification of an isotope of element 61, with a half-life of 3.7 years. It is formed by the β -disintegration of a neodymium isotope with half-life of 11 days, and decays into a stable samarium isotope. It is only a question of time when milligrams of this element, unknown in Nature, will be available for study.

The next of the missing elements, 85, was manufactured by Corson, Mackenzie and Segré in 1940, and its chemical character studied. The great significance of this work has

been emphasized before. We have to add now the interesting fact that about two years later Karlik and Bernert, in the Vienna Institute for Radium Research, obtained strong evidence that in all three natural radioactive series, isotopes of element 85 occur; they discovered new groups of α -rays, the energies of which agree very well with those to be expected for atoms of element 85 with mass numbers 218, 216 and 215; such isotopes could be formed in the radium, thorium and actinium series in the percentages observed, if either the A -members or the emanations showed a small tendency to β -disintegration in addition to their well-known α -decay. The experiments do not yet allow us to distinguish between these possibilities; whereas, therefore, the mechanism of the formation of these new branch products is still uncertain, there seems no doubt that the Misses Karlik and Bernert have to be credited with the proof of the existence of natural isotopes of element 85. Former claims were open to grave objections and were experimentally disproved by very careful work by the Vienna physicists.

Nothing new can be said about the undisputed discovery, reported earlier, of element 87 in the form of a natural isotope, actinium K, by Mlle. Perey.

The most spectacular development has taken place in the region of the trans-uranium elements. As is well known, this work had a direct bearing on the production of one type of atomic bomb and was secret during the War; but to-day a sufficient amount of information has been released to permit an appreciation of

the scientific value of the new discoveries.

If a neutron is captured by a uranium atom $^{238}_{92}\text{U}$, a new uranium isotope $^{239}_{92}\text{U}$ is formed which emits β -rays and changes, with a half-life of 23 min., into an element with a β -activity of half-life 2.3 days. The fact that this β -radiation, which had been observed before, belonged to the element 93 was proved by McMillan and Abelson early in 1940 with the help of chemical and physical experiments; they are, therefore, to be considered as the discoverers of the first transuranium element. As its name they proposed neptunium (Np), from Neptune, the first trans-Uranus planet. Owing to its short life-time, invisible quantities only of $^{239}_{93}\text{Np}$ are available. Later, however, A. C. Wahl and G. T. Seaborg found another isotope of neptunium, of mass number 237, which is an α -emitter with a half-life of 2.25×10^6 years; it is formed by the β -decay of a uranium isotope 237 (half-life 7 days), a substance which can be produced by bombarding $^{238}_{92}\text{U}$ with fast neutrons either in the cyclotron or, better, in the uranium pile. Of this long-lived neptunium species, hundreds of milligrams have already been obtained in the form of pure chemical compounds. A thorough investigation showed that the chemistry of neptunium closely resembles that of uranium; it can occur in the same valency states III, IV, V and VI, of which the lower ones are, however, more stable than the corresponding ones in uranium.

It has already been mentioned that $^{239}_{93}\text{NP}$ emits β -rays. Consequently, the daughter element occupies place 94 in

the Periodic Table; its half-life is about 2.4×10^4 years, and it decays with α -radiation, thus being the parent of $^{235}_{92}\text{U}$, the well-known actino-uranium which forms 0.7 per cent of the naturally occurring element uranium. This isotope of element 94 was found by J. W. Kennedy, G. T. Seaborg, E. Segrè and A. C. Wahl early in 1941; it was, however, not the first discovered; already in the preceding year G. T. Seaborg, E. M. McMillan, A. C. Wahl and J. W. Kennedy had shown that deuteron bombardment of uranium 238 led to an isotope of neptunium of the same mass number, which is β -radiating, and thus gives rise to an isotope of element 94 with the mass number 238. This new substance emits α -rays and has a half-life of about fifty years; its disintegration product is identical with the uranium II of the natural series. Following the tradition of the naming of uranium and neptunium, the discoverers of element 94 suggested for it the name plutonium (Pu), after Pluto, the tiny outermost member of the solar family, found in 1930. The study of the properties of plutonium was at the outset very difficult owing to the invisibility of the quantities available of $^{238}_{94}\text{Pu}$; but of $^{239}_{94}\text{Pu}$, with its long life-time, one could prepare by extended cyclotron bombardment an amount sufficient for chemical investigation, albeit at the beginning only for 'ultra-microchemical' studies. Later, by the use of the neutron-capture reaction in the uranium pile, very large quantities of plutonium have been manufactured for military purposes. Its chemistry, electro-chemistry, and physical properties are very

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accurately known. It has been disclosed that this element like neptunium, resembles uranium; again, we find the valencies III, IV, V and VI, valency III being more stable than in the case either of neptunium or uranium.

Since any desired amount of plutonium is now available in the laboratories engaged in the working up of the material of the uranium piles, it was only natural to try whether elements higher still in the Periodic Table could be obtained by bombarding plutonium in the cyclotron. G. T. Seaborg, R. A. James, L. O. Morgan and A. Ghiorso, in collaboration with J. G. Hamilton and his group of physicists, found that helium ions of very high energy (40 MeV.) actually produced isotopes of elements 95 and 96; not much has yet been published about their chemistry, but it seems that the general similarity of the transuranium group with uranium is maintained. This is no surprise if we remember that Bohr, so early as 1922, in his theoretical treatment of the Periodic System, predicted a kind of 'rare earths group' in this part of the table, beginning at, or shortly after, uranium. Following this analogy, the discoverers of elements 95 and 96 propose the names 'americium' (Am) and 'curium' (Cm), to emphasize the probable similarity of their electronic structure with their lower homologues europium and gadolinium. (Obviously there were no names of further planets available; should such ever be discovered in the future, a leading American astronomer believes that his colleagues would follow then the chemical nomenclature.)

I hope I have made it clear that,

in my opinion, if we observe the rules laid down above, there is scarcely room for any doubt as to who should be entitled to name the eight newly discovered chemical elements. For the elements 93-96 the question seems already settled, and the names neptunium, plutonium, americium and curium will most likely be generally accepted.

Francium: Number 87

As to element 87, a few more words are necessary. The name actinium K, as chosen by Mlle. Perey, is obviously only suitable for the particular isotope she discovered; the element, which may comprise various isotopes, should have a name not so closely linked with the special branch product of the actinium series. (Compare the sense in which 'polonium', which subsumes all the isotopes of element 84, is distinct from 'radium F', which is only the most important of the isotopes, and the first discovered.) As a result of correspondence with Mlle. Perey, I can state that she shares this view and proposes as the name for element 87 'francium' (symbol Fr).

So far no names for elements 43, 61 and 85 have officially been put forward by their discoverers Perrier and Segré, Coryell and his group, and Corson, Mackenzie and Segré, respectively. Every chemist concerned with the task of teaching systematic inorganic chemistry and of keeping his table of the Periodic System up to date will be grateful if they will publish soon the names which they consider suitable.

In the same issue of Nature, among the "Letters to the Editors," appear the two following letters naming ele-

ments 43 and 85. Inquiry by Science Service as to the naming of element 61 brought out the information given below as to plans for naming this, the last of the middle-weight elements known only in the form of unstable isotopes.

Technetium: Number 43

► In 1937, Perrier and Segré showed that radioactive isotopes of element 43 could be formed by neutron or deuteron bombardment of molybdenum. Several chemical properties of element 43 were established at that time, and some nuclear properties of the spectral isotopes. These isotopes were found after nuclear bombardments by the 37-in. cyclotron of the Radiation Laboratory of the University of California.

Later on, Wu and Segré found also element 43 among the fission products of uranium, a source from which relatively large amounts of 43 can be isolated.

It seems appropriate now to give a name to this element, as suggested by Paneth; and we would like to propose the name of 'technetium', taken from the Greek, meaning artificial, in recognition of the fact that technetium is the first artificially made element. The corresponding chemical symbol should be 'Tc'.

C. PERRIER

University of Genoa, Italy.

E. SEGRE

University of California,

Berkeley, California.

Nov. 29.

Astatine: Number 85

► In 1940, we prepared the isotope of mass 211 of element 85 by bombarding the bismuth with alpha particles accelerated in the 60-in cyclotron of

the Radiation Laboratory of the University of California.

At that time we established several chemical properties of element 85 and we made a fairly complete nuclear study of the isotope formed.

It has been pointed out to us that a name should now be given to this new element, and following the system by which the lighter halogens, chlorine, bromine and iodine, have been named, namely, by modifying a Greek adjective denoting some property of the substance in question, we propose to call element 85 'astatine', from the Greek and meaning unstable. Astatine is, in fact, the only halogen without stable isotopes. The corresponding chemical symbol proposed is 'At'.

D. R. CORSON

Cornell University,
Ithaca, N. Y.

K. R. MACKENZIE

University of British Columbia,
Vancouver, B. C.

E. SEGRE

University of California,
Berkeley, California.
Nov. 29.

Number 61 to be Named

► THE LAST REMAINING unnamed chemical element among the 96 now discovered will be christened in April by a paper before the American Chemical Society meeting at Atlantic City.

Element 61 was positively identified among the fission products of uranium at Oak Ridge, Tenn. during experiments in 1945 by J. A. Marinsky and L. E. Glendenin. Dr. Charles D. Coryell, now at Massachusetts Institute of Technology, was associated in

the work but does not consider himself one of the codiscoverers.

Two relatively fleeting varieties of this radioactive element were identified, one with an atomic weight of 147 that has a half-life of 3.7 years and another with a mass of 149 with a half-life of only 47 hours.

Element 61 has been given the name illinium on the basis of a reported discovery of some years ago that is not now generally accepted.

Professor Paneth's earlier paper, describing the predictable properties of the missing elements and giving the theory which accounts for their non-appearance among the elements of the earth's crust, is also reprinted here, followed by Mlle. Perey's description of the chemical properties of Actinium K, the isotope which she discovered, which is the alkali element she now names Francium.

Completing the Periodic System

RADIOACTIVITY AND THE COMPLETION OF THE PERIODIC SYSTEM, by Prof. F. A. Paneth, University of Durham, in NATURE, Vol. 149, p. 565, May 23, 1942. Quotation from latter part of the article.

► THE MOST EFFICIENT instrument for atomic transmutation is E. O. Lawrence's cyclotron. Of the overwhelming number of nuclear reactions carried out with its help, for the purpose of our present survey, in which we intend to omit all details of no immediate interest to the chemist, we need remember only two. In many cases when an atom of atomic number Z and mass number M is bombarded with deuterons ($\frac{2}{1}D$), an atom of atomic number Z + 1 and mass number M + 1 makes its appearance while one neutron per atom is liberated. If the bombardment is carried out with helium nuclei ($\frac{4}{2}He$) an element Z + 2 of mass M + 2 may be formed, this time with emission of two neutrons per atom. The newly created atoms are mostly unstable; thus these two reactions give us the possibility

of producing radioactive elements one and two places higher in the Periodic System than the bombarded elements. Their application has provided active forms of all three missing elements for chemical investigation. Here are the main results.

Element 43, Mendeléeff's eka-manganese, was obtained by bombarding element 42, molybdenum, with deuterons. At least five radioactive isotopes of atomic number 43 were recognized; as their half-value periods were of the order of hours and days, a study of their chemical behaviour was possible. It was found that element 43 can be precipitated with hydrogen sulfide from alkaline and (not too) acid solutions; that it can easily be deposited electrolytically; and that its oxide is volatile. All this shows that it resembles more its higher homologue, rhenium, than its lower, manganese. It may be mentioned that the identity of one of the isotopes with element 43 could be verified even by the measurement of the K α line of its X-ray spectrum; not in the usual way,

ment 61 follows the other rare earths. Now rhenium has been prepared in hundreds of kilograms, but not the slightest trace of element 43 was ever found associated with it. For element 61 a special search has been made, among others, by Auer von Welsbach, who not only had unusually large quantities of rare-earth material at his disposal but possessed also an unrivalled experience in their fractional separation; he came to the conclusion that no rare earth existed between neodymium and samarium.

To this we may add that, quite independently of these experimental facts, a general rule seems to exclude the possibility of a stable element 43 or 61. J. Mattauch has directed attention to the absence, or, at least, extreme rarity, of stable isobars (that is, atoms of equal atomic weight) belonging to neighbouring elements. If two neighbours in the Periodic Table have isobars, one of the atomic species is almost invariably unstable, changing into its isobar by emission of an electron or a positron (or both). For example, $^{40}_{19}\text{K}$ is isobaric with $^{40}_{18}\text{A}$ and with $^{40}_{20}\text{Ca}$; in accordance with Mattauch's Rule, $^{40}_{19}\text{K}$ emits β particles thus changing into $^{40}_{20}\text{Ca}$ (and perhaps also positrons, thereby producing $^{40}_{18}\text{A}$, the astonishing terrestrial abundance of which has been tentatively explained by this assumption). If Mattauch's Rule is valid in the region of the elements 43 and 61, there are no stable isotopes of these two elements possible, as all mass numbers are occupied by stable

isotopes of their neighbors. Element 42, molybdenum, possesses the stable isotopes 92, 94, 95, 96, 97, 98 and 100; element 44, ruthenium, 96, 98, 99, 100, 101, 102 and 104; so for element 43, the combining weight of which ought to be between molybdenum and ruthenium, no atoms with masses between 94 and 102 are available. The case of element 61 is similar.

For element 85 Mattauch's Rule makes no prediction, since from element 84 onwards no stable atoms are known. Nor are the negative results of the experiments carried out so far in search of this element conclusive: for it was generally supposed that in the course of analytical separations it would follow iodine, while we know now that it is much more like polonium and bismuth. The task of the chemist embarking today on a new attempt at its discovery would be facilitated not only by this knowledge but also by the opportunity of adding the artificially produced radioactive form of element 85 as an 'indicator' to his material; the α -rays, decaying with the characteristic period of 7.5 hours, would show him at once in which fraction the looked-for natural element, if present at all, is concentrated.

Even if it should be impossible to detect any of the three missing elements on the earth, it is not unlikely that they possess a transitory existence in the course of the innumerable thermo-nuclear reactions occurring in the interior of the sun and other stars.

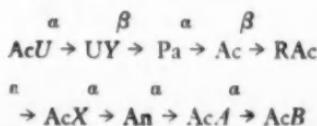
Actinium K

ELEMENT 87: AcK, Derived from Actinium; by Mlle. M. Perey. *Journal de Physique et le Radium, Series VII, Vol. X, No. 10, p. 435, Paris, October 1939.* Translated for CHEMISTRY by Helen M. Davis.

Summary—Announcing the formation of a new naturally radioactive element: AcK with a period of 21 m. emitting β radiation, of atomic number 87, produced by α ray emission from actinium. The ratio of the branching of actinium should be on the order of 99 per cent disintegration by the known β process and one per cent by a disintegration.

► ACTINIUM, a naturally radioactive substance, discovered by Mr. A. Debierne, seems to belong to the rare earths by its chemical properties. It gives rise to radioactinium, an isotope of thorium, with a period of 18.9 days which by α emission changes into actinium X, an isotope of radium. AcX, with a period of 11.2 days, decays in its turn by α radiation into actinon, giving the whole series from the original active material, ending in actino-lead.

Actino-uranium, whose period is 7.1×10^8 years, an isotope of uranium, occurring in natural uranium in the proportion of 0.7 in 100, is the first member of the family of actinium giving uranium Y, $T = 1.02$ days, then protoactinium, higher homologue of tantalum with a period of 32,000 years, which by α disintegration gives actinium.



The period of actinium is not well known. The value lies between 7 and 22 years and is considered $T = 13.5$ years.

By chemical analogy the number 89 in Mendeleeff's classification may be attributed to actinium.

The characteristic radiation of actinium being very difficult to study, it has been believed that its transformation into R Ac is by emission of feeble β radiation.

Hull, Libby and Latimer give 220,000 eV as the value of the maximum β radiation of actinium.

In 1914 St. Meyer, Hess and Paneth announced very feeble α radiation of 3.5 cm range due to actinium. In 1927, St. Meyer and Schweidler attributed these rays to the presence of traces of protoactinium, a substance which had been discovered in the meantime and which possesses α radiation very close to that which they had observed.

In the course of the experiments which are to be described here, I have been able to find evidence for α radiation of 3.5 cm range attributable to actinium itself and giving, as a result of this disintegration, a new naturally radioactive substance: actinium K, with a period of 21 minutes, having the properties of the alkalis and occupying place 87 in Mendeleeff's table. . . .

Chemical Properties

It is necessary to describe the chemical identity of this new naturally radioactive substance formed by disintegration of actinium.

Take some actiniferous lanthanum, deprived of its derivatives, showing during the first hours increase of activity up to a certain level; dissolved at that moment and precipitated with ammoniacal ammonium carbonate or ammonium sulphhydrate, it will produce again the level formerly observed. The mother liquors have a β activity which decreases with a period of $21 \text{ m} \pm 1$ which was that of the formation of the new substance in the actinium.

An aqueous solution, in contact with actiniferous lanthanum fluoride, shows, after filtration, a β activity decreasing with a period of 21 minutes.

There is no carrying, in the mother liquors, by means of the salts of sodium or potassium, but by simultane-

ous crystallization with the perchlorate of cesium or rubidium, or the chloroplatinates of these two metals, I have obtained crystals whose β activity decreases with a period of 21 minutes.

Since only the perchlorates of potassium, rubidium and cesium precipitate, we are therefore in the presence of an alkali, derived from actinium and hence a higher homologue of cesium, element 87 of Mendeleeff's table, of atomic weight 223.

It is said that M. Hulubei observed by means of an X-ray spectroscope, in the products of the treatment of pollucite, lines corresponding to element 87. He deduces the presence in this mineral of a stable element having this number, to which he has given the name moldavium. If the results of this author are confirmed, there exist then at least two isotopes of atomic number 87, one of long life, the other radioactive, which we have described.

Mica Substitute Available

► MICA SUBSTITUTE, a German wartime development for use in electrical instruments, may find American applications in the manufacture of high frequency insulation materials for radar and other equipment. It is a synthetic resin.

Manufacture of this material involves making a vinyl resin known as vinyl carbazole and changing it into a polyvinyl carbazole. A solution of this in tetrahydrofuran can be cast in thin foils. These were used as mica substitutes in condenser dielectrics in Germany.

A report, prepared by Dr. G. M. Kline of the National Bureau of Standards, who studied the method in postwar Germany, has just been issued by the Office of Technical Services, U. S. Department of Commerce.

Orders for the report (*Polyvinyl Carbazole in Germany*: PB-33272; photostat, \$1; microfilm, \$1; 11 pages) should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D.C., and accompanied by check or money order, payable to the Treasurer of the United States.

For the Home Lab

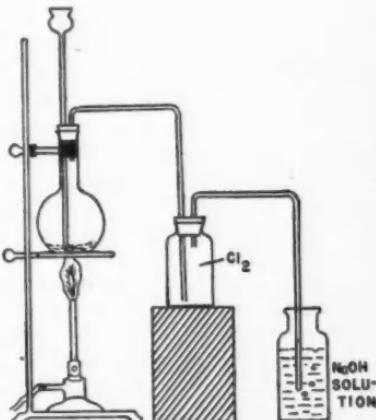
The Hot-Headed Halogens - I

Chlorine

by BURTON L. HAWK

► LET US IMAGINE ourselves in the year 1774. And let us enter the laboratory of one Carl Wilhelm Scheele in Sweden. His laboratory is simple; he, of course, has none of the modern equipment which we deem essential in our laboratories of today. He is intensely absorbed in his work. Upon closer examination we find he is experimenting with the mineral *pyrolusite*, which, he believes, contains a new substance. He now adds hydrochloric acid to a portion of pyrolusite and after a while he notices a greenish gas arising from the vessel. This commands his full attention, as he does not recall any vapor that is like this. He sniffs the gas and finds that it has a sharp, suffocating odor. He is puzzled. What can this be? He is so handicapped by lack of knowledge! He does not know his acid is composed of hydrogen and chlorine. And he does not know the pyrolusite contains manganese dioxide. And he can never guess that the mineral is oxidizing the acid and thus setting the chlorine free. And, lastly, he does not realize that he has discovered a new element—*chlorine!* In fact, it is considered a compound for over 36 years, when it is finally proven to be an element by none other than the illustrious Sir Humphrey Davy.

Now back to the twentieth century, where we can prepare the same chlor-



Preparation of Chlorine

► When collecting-bottle is filled with chlorine, remove wooden block first, then bottle. Quickly insert second bottle in stopper; replace wooden block.

ine from the same materials used by Scheele with the added advantages of purer compounds, better equipment, and more knowledge . . . we hope.

A suggested set-up for collecting chlorine is shown in the accompanying diagram. Place two or three grams—no more—of manganese dioxide in the generator flask. Add hydrochloric acid through the thistle tube. Apply gentle heat and collect several bottles of the gas. The excess chlorine is allowed to bubble through a solution of sodium hydroxide where it is absorbed. Precaution must be taken, as chlorine is

very poisonous. Prepare only small quantities at a time in well ventilated surroundings. Do *not* inhale the gas! If you do accidentally inhale a large quantity of chlorine, breathing ammonia fumes will help relieve irritation.

Chlorine can also be obtained from common salt. Mix equal quantities of salt and manganese dioxide (about 1 gram of each) and place in the generator. Pour dilute sulfuric acid through the thistle tube. In this reaction, hydrochloric acid is formed by the action of sulfuric acid on the salt and is immediately oxidized by the manganese dioxide.

Chlorine is extremely active as can be demonstrated by the following reactions: Powdered antimony sifted into a jar of chlorine will burst into flame forming antimony trichloride, $SbCl_3$. Powdered iron, heated moderately, glows brilliantly to form ferric chloride, $FeCl_3$. A piece of filter paper moistened with turpentine ignites spontaneously in chlorine, emitting large clouds of soot. Colored papers, cloths, flowers, etc. when moistened with water are bleached white by chlorine. Actually, substances are not bleached by chlorine but by the hypochlorous acid which is formed by chlorine and water. And to be still more technical, it is not the hypochlorous acid but the atomic oxygen released by this compound that is really responsible for bleaching. Or, in a nutshell, the bleaching action of chlorine is due to oxygen . . . !

Heated copper foil will burn in the gas resulting in a mist of cupric chloride, $CuCl_2$. Phosphorus burns feebly

in chlorine to form the trichloride, PCl_3 , or pentachloride, PCl_5 , depending on the abundance of chlorine. (Use only a *very* small piece of phosphorus). Melted sulfur unites to form sulfur monochloride, S_2Cl_2 . Sodium unites with chlorine to form, obviously, sodium chloride.

To prepare synthetic salt, place a small, dry, freshly-cut piece of sodium in a jar of chlorine. It might be well to place the metal in a dry deflagration spoon; then lower into the jar. Allow to stand for about 30 minutes. Close examination will then reveal a white powder which is common table salt, although a rather expensive way to prepare it. If you are skeptical, dissolve the product in a large volume of water. Use a large container in the event all sodium has not reacted. Add silver nitrate and note the white precipitate indicative of the chloride ion. We do not recommend tasting as a method of proof.

Chlorine has many uses. In peace times it is used in the purification of water to save lives. In war times it is used in poison gases to destroy lives. However, its latter use is being replaced by the atom bomb, which has been found to be much more effective. It is also used in the manufacture of dyes, drugs, explosives, disinfectants, germicidal preparations, in extracting gold from its ores and in reclaiming tin from "tin" cans.

We often wonder what Carl Wilhelm Scheele would say if he could see now the widespread use of the "greenish vapor with suffocating odor" which he first observed 173 years ago.

Lead Shortage Blamed: U. S. Production Less

Automobile Battery Shortage

► THIS has been a hard winter for automobile owners whose cars need new batteries. The shortage of batteries is due to a shortage of lead.

The United States is one of the world's greater lead-producing nations but even in the lush production years two decades ago it did not mine enough to meet all domestic needs. It imported about one-eighth of the total consumed, which included recovered lead as well as metal just from the ground.

Since before 1930, American production has been decreasing more or less steadily. By 1941, the domestic metal available, both from mining and the recovery of used lead, was about four-fifths the average available each year in the 1925-29 period. Imports offset the decrease. The lead mined in 1944 was about 80 per cent of the 1941 production, or 60 per cent of the 1925-29 average.

Production in tons illustrates the point. The average annual lead refined from ore during the 1925-29 period was approximately 660,500 tons. In 1944, less than 395,000 tons were produced. For 1946 the production is estimated at approximately 335,000 tons.

America each year uses great quantities of reprocessed old lead. This secondary recovery in the 1925-29 period was 280,000 tons a year. Much larger recovery prevailed during the war years, but it had dropped to 332,000 tons in 1944. Recovery last year is pre-

dicted as much less, but figures are as yet unavailable.

The decrease in lead production in the United States is due to depletion of ore deposits in certain districts, and to manpower shortage during the war and since. Strikes have been a factor. Shortages abroad are due to lack of equipment and manpower resulting from war devastation. Little lead may be expected for some time from Germany, Yugoslavia and Burma, and even lead imports from Mexico will be curtailed.

There is enough lead produced now in the United States to meet battery needs, but there are many other uses for lead that are just as important. Great quantities are needed in the housing program, electric cables require lead conduits, paint uses lead pigments, and even the anti-knock compound used in gasoline is a lead chemical.

Not all storage batteries, of course, require lead. Other kinds of batteries, however, are not suitable for automobiles. Neither are the "one-shot" lead batteries developed for war purposes. The best known non-lead battery is the Edison nickel-iron type that uses caustic potash as an electrolyte. Because of large internal resistance, Edisons are not adapted for starting automobiles. Their field is motive power for electric trucks, the lighting of railroad cars and similar applications.

There is also the Swedish nickel-

cadmium storage battery, for the suppression of the manufacture of which the U. S. government brought suit against two American firms in 1945. This battery, invented in 1899, came into wide use in Europe, in the decade before the war, on trucks and buses. It

can be used on automobiles, it is claimed, but the supply in America is very limited. A Massachusetts company is reported as now manufacturing a battery of this type, but the production can hardly help the present shortage.

New Chlorinated Synthetic Rubber

► SYNTHETIC RUBBER now can replace natural rubber in another field—in the production of chlorinated rubber for ship-bottom paints, anti-fouling paints, and non-inflammable paints. Chlorinated synthetic rubber can be used also in the preparation of sand-core binders for molding operations, adhesives, and other products. The new synthetic chlorinated rubber is a development of the Goodyear Tire and Rubber Company in its laboratories.

The chlorination of natural rubber is carried on at fairly low temperatures, the rubber being dissolved in carbon

tetrachloride and chlorine gas passed through the solution. The result is the formation of a new molecule that might be called "natural rubber chloride."

The new chlorinated synthetic rubber is a creamy white powder containing from 60 per cent to 70 per cent chlorine. It is equal to the natural rubber product in every way, it is claimed. It is soluble in all aromatic hydrocarbons, including benzene and toluene, and also in esters like ethyl acetate and in chlorinated hydrocarbons. It has excellent anti-corrosion qualities.

Super-Cutting Alloy Without Tungsten

► A SUPER-CUTTING metallic alloy which contains no tungsten was developed in Germany for war purposes. The new cutting material consists essentially of vanadium and titanium carbides bonded with metallic nickel.

Information relative to the new material is given in an article by Prof. Gregory Comstock of the Stevens Institute of Technology, released for publication by the War Production Board. Prof. Comstock, who is director of the Institute's powder metallurgy laboratory, went to Germany before V-E day, and followed the Army in its advances into the Reich. His job

was an investigator for the government-sponsored Technical and Industrial Intelligence Committee to study German scientific and technological developments during the war.

Prof. Comstock was able to secure data covering the amount of the new alloy made in Germany and Austria. One of its principal values to the Germans was that it freed their limited supply of tungsten for other uses. No tungsten is produced in Germany, and Hitler's war machine depended for this essential metal in modern steels upon importations, principally from Spain and Portugal.

Chem Quiz

Can You Tell Them Apart?

► HERE ARE a few apparent twins and triplets among chemical names. Do you have trouble distinguishing them?

Benzene

Benzine

Benzoin

Fluorene

Fluorine

Hexane

Hexene

Hexyne

Ketene

Ketine

Ketone

Luminal

Luminol

Populin

Popular

If it is any help, you will find their formulas, as far as possible, on page 50.

See Through Back of New Mirror

► PEAKHOLES in apartment doors are no longer necessary. A window pane that is a mirror from the outside can be used instead. To the person on the inside it is a clear glass.

This transparent mirror is now in production and available for civilian uses. It was developed early in the war and served many war purposes, particularly to meet aircraft demands for high-quality instruments. It was developed by Libbey-Owens-Ford Glass Company.

The treated glass functions as a reflecting surface when seen from one side, and simultaneously as a window when viewed from the other. The treatment is called a "molecular bombardment" with a special chrome alloy through thermal evaporation in a high vacuum. The reflecting surface is the one that is metal-coated.

Key to the transparent mirror's performance is the almost incredible thin-

ness of the film of chromium alloy applied. It is four ten-millionths of an inch thick. While constituting an effective reflecting surface, it is so thin that clear photographs can be taken through it.

In making the mirrors the glass to be coated is placed around the inside of a vacuum chamber, and the chromium particles are suspended on a filament in the center. After powerful pumps have created a very high vacuum in the chamber, an electric current is passed through the filament. The current instantly evaporates the metal, molecules of which dash with the speed of light to the glass. They cling so tightly that they can not be removed by scrubbing.

Glass can be similarly coated with silver, gold, aluminum, lead and other metals. The transparent mirror is suitable for use in many applications where one-way observation only is desired.

Love Chemical for Algae

► THE ELIXIR of Love, vainly sought by medieval alchemists, actually exists—for certain microscopic lower plants. It is a compound known as crocetin, together with a few of its chemical derivatives. One part of this in 250 trillion parts of water will cause cells of the plant to quit a quiet, sedentary, sexless phase of existence and become actively motile, mate-seeking sexual cells.

The plant concerned is the one-celled lower alga called Chlamydomonas. Details of its astonishing sex-chemistry are presented in the new issue of the American Journal of Botany by Prof. Gilbert M. Smith of Stanford University. Others have also

carried on research in this field, most notably a botanist named Prof. F. Moewus, in pre-Hitlerian Germany.

The sex life of Chlamydomonas also presents another dizzying peculiarity. The clever poet who tosed off the couplet:

"Breathes there a man with a soul
so tough
"Who says two sexes are not
enough?"

should have studied a little botany. This plant has not two sexes, but ten. It produces five types of female cells, and five of male, all reacting with different degrees of intensity to their opposite numbers. All of which makes life at that level rather confusing.

Motor Fuels From Farm Wastes

► MOTOR FUELS made synthetically from farm wastes have entered production in an experimental plant of the U. S. Department of Agriculture, at Peoria, Ill.

The plant will produce alcohol. It is the Bureau's contribution to the government's research program for producing liquid motor fuels from non-petroleum sources. Production from agricultural products was assigned to Agriculture; production from oil-bearing shale, coal and natural gas is under research by the Bureau of Mines.

The new plant will handle enough farm residues to provide fermentable material for the production of 500 gallons of alcohol daily. At capacity, it will produce 2,000 pounds of glucose

in 10% solution, 1,600 pounds of hylose in 15% solution, 200 pounds of furfural, and 1,000 pounds of liquid in eight hours.

The process used in the new plant, for producing fermentable sugars from which the liquid fuels are obtained, is an outgrowth of research at the Northern Regional Research Laboratory of the Department of Agriculture by Drs. E. C. Lathrop and J. W. Dunning. The farm wastes to be used include corncobs, sugarcane bagasse, peanut shells, flax shives, and the hulls of oats, cottonseed, and rice. Grain straw and cornstalks can also be used in the process. They are the waste products that are available in fairly constant quantity each year.

Splitting of Ytterbium Closed the Rare Earth List

Lutecium, Named for Paris

A Classic of Chemistry

A NEW ELEMENT: LUTECIUM, resulting from the division of Marignac's ytterbium. Note from G. Urbain, presented by A. Haller. Comptes Rendus, vol. 145, p. 759 (1907). Translated for CHEMISTRY by Helen M. Davis.

►IN THE SEPARATION of the elements of the yttrium group, I have always observed that ytterbium gives the most soluble salts. The method which seems to me the most practical for obtaining this substance, free from yttrium, erbium and thulium, is crystallization of the nitrates. (G. Urbain, *Bull. Soc. ch. t.* XXXIII, 1905, p. 739; *Journal de Chimie physique*, t. IV, 1906, p. 31; extract from a private communication made to Sir W. Crookes 5 May 1906 and published by the latter: *Proc. Roy. Soc. vol. LXXVIII*, 1907, p. 154). I have obtained in 1905 by this method about 50 grams of raw ytterbium corresponding to the description given by Marignac (*Comptes rendus t. LXXXVII*, p. 578).

I shall publish in summary form in this preliminary Note the researches which I have been pursuing constantly since that time.

One must always analyze the sulfates of such products to determine the atomic weight of ytterbium. It seemed to me necessary to submit ytterbium to systematic fractionation to assure myself of the constancy of its atomic weight and its characteristic spectra.

For this purpose, I subjected the

nitrates to new fractional crystallizations in nitric acid of density 1.3. I thus obtained, after a very laborious task of fractionation, carried through 22 consecutive fractions, a series of products which I first examined from the point of view of absorption. The first fractions, numbered from 9 to 16, showed clearly those absorption bands which, alone, actually define thulium. I eliminated those fractions. The other fractions which could be considered as those of pure ytterbium were changed into sulfates and analyzed.

Far from being constant, the atomic weights varied, increasing progressively from 169.9 for fraction 17 to 173.8 for the last fraction, No. 31.¹ One such considerable variation is sufficient to establish the complexity of the real ytterbium.

I found thorium at the tail of my fractionations. By the very efficacious method of MM. Wyrouboff and Verneuil (action of hydrogen peroxide on a neutral solution of the nitrates), I have been able to separate from my earths of the highest atomic weight about one five-thousandth part of thorium, which could not have any influence on my measurements.

¹For this first approximation I used in my calculation $O = 16$, $H = 1$, $S = 32$. These numbers are high by about 0.17 if one takes as the base of calculations $O = 16$, $H = 1.008$, $S = 32.06$. It should be noted here that the atomic weight of thulium cannot be 171. This constant is certainly less than 168.5.

By the method of arc spectra I have not been able to show the presence of impurities in my products thus purified, and it was unquestionable that my ytterbium was indeed a mixture of several constituents.

By photographing upon the same plate, one below the other, the arc spectra of the extreme products of the fractionation, I found in the spectrum of the last fraction (No. 31) numerous lines, for the most part strong, which could not be found in the fraction at the head (No. 17), or which appeared only very feebly. On the other hand, fraction 17 showed some lines of little intensity, absent in fraction 31 and probably attributable to thulium. Independently of these lines, the two spectra showed a great number of lines in common with intensities of the same order. These lines are those which characterise the principal amount of the material in the beginning whose impurities (thulium and the new element) have accumulated, the one at the head and the other at the tail, of my fractionation.

I then compared the spark spectra of my earths. The differences controlled by this method of observation were much more manifest than in the case of the arc spectra.

1. The following lines are the bright lines attributable to thulium which I found in the fractions with less atomic weight (the least soluble nitrates):—

2869.3	weak
2899.9	medium
2962.5	"
3050.9	weak
3131.4	rather strong
3151.2	medium

3173.0	medium
3362.7	rather strong
3425.7	"
3441.6	"
3461.9	"
3624.5	weak
3712.5	"

2. The following lines are the lines characteristic of the new element. They are very easily seen in the fractions of higher atomic weight (the more soluble nitrates). They appear there exclusively or there they are extremely strengthened:—

* 2701.8	very strong
* 2754.2	"
* 2798.3	"
* 2847.6	"
2895.0	"
* 2900.4	"
* 2911.5	"
* 2951.8	"
* 2963.5	"
2970.0	"
* 2989.4	medium
3020.7	very strong
* 3056.8	"
3058.0	"
* 3077.7	"
* 3080.3	medium
3118.6	"
3171.5	rather strong
* 3183.5	medium
3191.9	"
* 3198.2	strong
* 3254.5	very strong
3275.5	rather strong
* 3312.4	strong
* 3359.8	"
* 3376.7	"
* 3385.6	rather strong
* 3397.2	very strong
* 3472.6	"
* 3506.8	"

3554.6	very strong
3568.0	strong
3624.1	"
3647.9	"

The lines marked * are most characteristic of the arc spectra.

Within the limits between which my measurements were made, these 34 lines constitute the relatively complete spark spectrum of the new element.²

I propose for this new element the name of *lutecium*, Lu, derived from the ancient name of Paris.

3. The other lines, comprised between the same limits and counted in the spark spectrum of ytterbium described recently by Sir W. Crookes from one of my former preparations (*loc. cit.*), characterize the principal body of the old ytterbium. I propose to give to that earth the name of neo-*ytterbium*, Ny in order to avoid confusion with Marignac's old element.

4. The spectrum first recognized as old ytterbium was described by M. Lecoq de Boisbaudran (*Comptes rendus* t. LXXXVIII, 1879, p. 1342) to which Marignac confined his new earth. It is a line spectrum. Upon observing by M. Lecoq de Boisbaudran's method the chlorides of the extremes of my fractionation, I noted with the earths of less atomic weight (neo-*ytterbium*) the absence of M. Lecoq de Boisbaudran's line γ . On the other hand, with the earths of higher atomic

weight very rich in lutecium, this line γ has an intensity equal to the other lines of the spectrum.

The lines α (from $\lambda = 559$ to $\lambda = 552$) and β (from $\lambda = 576$ to $\lambda = 568.5$) therefore are probably characteristic of neo-*ytterbium* and the lines γ (from $\lambda = 517.5$ to $\lambda = 513$) lutecium.

In summary, from all the preceding observations it follows that Marignac's ytterbium is a mixture of two elements: neo-*ytterbium* and lutecium. The atomic weight of neo-*ytterbium* should not be much higher than 170 and the atomic weight of lutecium should not be much greater than 174.

I believe it should be recalled that Demarçay (*Comptes rendus*, t. CXXXI, 1900, p. 387) designated as θ an element characterized by lines 4008.2 and 3906.5. He considered it as distinct from thulium and comprised between erbium and ytterbium. I have not been able to observe these lines, obtained by the use of a special coil, either in my line spectra or in my spark spectra.

Similarly, M. Auer von Welsbach (*Lieb. Ann.* t. CCCLI, 1907, p. 464) has quite recently announced that fractionating the double oxalate of ammonium and ytterbium gave him the opportunity to observe spectrum variations which he has not stated precisely. He has only given the measurement of the lines which he has observed as between $\lambda = 7000$ and $\lambda = 5000$, and he has in no way specified the elements whose existence he predicates in the old ytterbium.

²None of these lines is attributable to scandium, to thorium, to erbium, to thulium, to yttrium, or to any ordinary element, nor to any rare earth except the old ytterbium.

Clays Often Betray Hidden Mineral Deposits

New Wrinkles in Prospecting

► THE CLAYS in the vicinity of hidden mineral deposits are now being used to betray the presence of the ore, thanks to X-ray, the electronic microscope, thermal analysis methods, and the old-time chemical analysis for traces of the mineral.

The technique employed is known as "alteration study." Its extended use in searching for new deposits of minerals to replace depleted reserves is revealed by Prof. Paul F. Kerr, of Columbia University, who is partly responsible for its development and who has used it for the past five years.

Particular attention in alteration study, he states, is paid to the processes of nature that have destroyed original rocks and left in their place clay and various other types of alteration material. A determination of their mineral contents furnishes the clue that leads to the mineral deposits. When the alteration study technique is further developed, he predicts, it will be a valuable weapon in the search for new mineral deposits.

The mineral industry finds itself in somewhat of a dilemma, Professor Kerr continued. On the one hand new mineral deposits are becoming difficult to find. On the other, known deposits continue to be depleted even more rapidly. The alternatives are simple. Either the rate of discovery must increase, or metals necessary to modern civilization will become economically unavailable. It is a situation to which President Truman referred in his re-

cent report to Congress on the state of the nation. The President warned that improvement in the rate of discovery was needed because the country rapidly was becoming a "have not" nation with respect to some metals.

On the nation's danger list are copper, lead and zinc. The situation with respect to these metals is one of considerable concern, according to Professor Kerr. Figures are hard to obtain and reserves difficult to estimate. The country is not going to run out of copper, lead and zinc within the next few years but these metals could easily become too scarce to justify mining economically within the next generation. Also on the list of dwindling resources are aluminum, tin and chromite.

All known scientific methods have been directed toward stepping up the rate of discovery of metals, Professor Kerr says. In use today are special types of equipment such as spectrometers and airborne magnetometers. The latter is a device which hangs below a plane and records magnetic deposits in the land over which the plane flies.

"If methods are only partially successful, they are justified," Professor Kerr said. "In many cases what is needed is an improvement of an old technique."

Professor Kerr has been a member of Columbia's geology department since 1923. Every summer since then, when he was in the United States, has been spent doing field work.

Frivolous Effervescence and Caustic Comment

by OUR READERS

The title of this new department in CHEMISTRY seems to cover the scale over which our readers' correspondence ranges. We love the frivolous effervescence. We are humbly grateful for the caustic comment, especially when the Chemlins (Chemical Gremlins, of course) have been at work on the copy. Lots of our readers have good ideas, which we want to pass along to all who may be interested. Some of them want help from fellow chemical enthusiasts. We cannot promise to print all the letters, and we cannot undertake any research projects, but we hope to bring some interesting communications, from time to time, when space is available, from one interested reader to another.

the writings of chemists who have made important discoveries in the past. While the results of such work, of course, are incorporated in text books, something of value is apt to be lost in this process."

* * *

► "CHEMISTRY explained the word aldehyd as derived from alcohol and dehydrated. This is not correct," says Dr. S. F. H. of Northfield, Vt. "Dehydrated alcohol is ethylene and not aldehyd. It should have been al(cohol) dehyd(rogenized).

"The part *hyd* is from the Greek *hudor* which means water, but hydrogen as the water-former gets part of its name from the same word so the prefix *hyd-* sometimes means water and sometimes, as in *aldehyd*, it means hydrogen.

"Aldehyd is an interesting word as it comes from three languages. It would, on this score, be condemned by the philologists. *Alcohol* is Arabic, *de* is Latin, and *hyd* is Greek.

"CHEMISTRY uses the word *inflammable* correctly, but I hope that it and all other scientific journals and textbooks will instead use the shorter and safer word *flammable* which means the same: easily combustible. *Inflammable* is likely to suggest *not* flammable, as the prefix *in-* means *not* in so many words—insane, inert, etc. Dictionaries justify flammable and scientists are using it more generally."

► ONE OF OUR frivolous readers wants to know whether a silicone is a comic section?

* * *

► "CHEMISTRY is a most fascinating magazine and has given me an opportunity to review the chemistry I learned (or should have learned) at school," says Mrs. M. M. F. of Houston, Texas.

* * *

► THE CLASSICS of Chemistry appeal to Mr. W. A. G. of New York City. He writes: "I believe that both laymen and professionals will find pleasure and profit in reading extracts from

Vitamin Factories Supplement Farm
Says 1946 Perkin Medalist

Synthetic Vitamins and Nutrition

by DR. ROBERT R. WILLIAMS,
Director of research of the Research Corporation

► NO DOUBT the principal motivation of the many genuine scientists who have concerned themselves with vitamins has been curiosity as to how these pinches of stuff work and why we need them. This curiosity has been greatly rewarded though not yet satisfied. The vitamins have furnished several new and important chapters of enzymology, a book which has only begun to be written. The first chapter told us that enzymes are proteins, though that was for a long time controversial. It also furnished the concept but not the specific evidence that enzymes work by combining temporarily with successive molecules of the substrate thereby energizing each to chemical action and passing on to the next. It is like the thrill of partner after partner in a Virginia Reel.

It was not, however, till the vitamins came on the stage that we were able to identify the hands of an enzyme through which it exerted its thrill. First, riboflavin and later and even more explicitly thiamine were shown to be coenzymes, detachable members of enzymes, simple enough for us to learn their structure and synthesize them, yet potent for the functioning of the giant enzyme itself. Dialyse a solution of carboxylase, the enzyme which decarboxylates alpha keto acids. The diffusate contains the small molecules of thiamine pyrophosphate, cocarboxylase, which have

passed through the membrane. The dialysate retains the big molecules of the apoenzyme, a protein. Neither one works. Recombine them, and the activity is restored.

Almost all of the B vitamins have now been shown to enact such a role of coenzyme. In many instances analysis of body fluids of men or animals suffering from deficiency shows that the specific chemical reaction which the enzyme in question promotes in normal life has come to a halt in disease. An almost endless vista of opportunities is presented for using these vitamins to discover what reactions go on in the body and by what succession of steps the transformations of living cells occur. There are thousands of enzymes each more or less specific in action. Some may be substitutes for use in case the leading player is put out of action. Hundreds of enzymes, however, belong to the first string squad. Some vitamins play the part of coenzyme to more than one enzyme system.

A second, and to me more significant, consequence of this chapter of enzymology is the proof which has been afforded of the biochemical kinship of all or nearly all living things. We are discernibly related biochemically to the vegetables we eat, to the bacteria that infect our blood streams, to the insects that plague us. We find the same enzymes which man uses

also in the cells of living things whose progenitors presumably antedated man on the planet by hundreds of millions of years. The chemical descent of man extends his perception of kinships and his sense of the trends of evolution through far greater ranges than the anatomical evidence with which Darwin had largely to be content. It tells us where we have come from and if we read it wisely and well, I believe it may also tell us much about where we are going. It provides a possible new basis for sociology, so far almost completely ignored.

Further outgrowths of vitamin knowledge are still sprouting. One ought at least to mention the antivitamins. The first to be noted was sulfanilimide which proved to be an antivitamin for para-aminobenzoic acid. The two are identical in every way except for replacement of the carboxyl group by a sulfonamide group. Apparently either is capable of fitting itself to the apoenzyme so the two compete with one another in forming this alliance. However, the apoenzyme when paired with para-aminobenzoic acid performs an enzyme function; when paired with sulfanilimide it does not. It is thus then that sulfanilimide is believed to effect bacteriostasis, that is by impairing an enzyme function essential for the life and growth of the bacterium. Out of this has grown an entirely new philosophy of chemotherapy.

Many other antivitamins are now known. They have arisen from the study of the analogs of the vitamins. In a few instances a substance which very closely resembles a given vitamin in structure acts more or less effectual-

ly as a vitamin; much more frequently the resemblance is sufficient to permit it to combine with the apoenzyme but not to permit the pair to act on the substrate. In general the near-vitamins are accordingly antivitamins. More of either vitamin or antivitamin can offset the action of the other.

This thumbnail sketch of vitamin history would be distorted if mention were omitted of an excursion into genetics which has occurred. As Beadle first showed the genes of micro-organisms can be modified by exposure to X-rays so that among the surviving organisms are found some individuals which have lost a chemical mechanism possessed by the mother organism. Subsequent generations breed true to the characteristics of the mutant strain. In this way new organisms can be generated with a great variety of biochemical modifications. Each becomes useful for the study of the course of a particular biochemical process. The geneticists of course are greatly interested for these findings tend to confirm the conjecture that each gene is an enzyme and the chromosome a bundle of chemical agents which represent the sum total of heredity.

So much for the scientific and philosophical implications of the vitamins. However, I do not share the view of a legendary German professor who thanked God that no discovery of his had been prostituted to practical use. I value the synthesis of vitamins for its usefulness as well as for enlarging our horizons. From the beginning we wanted them pure in the hope they would thus be more effective therapeutic agents for deficiency diseases. In one sense they have proved so; in

another, the problem was complicated by further discovery. The vitamin B which we once worshipped as Jove has turned out to be a pantheon of divinities. We must invoke them all to effect complete healing. Yet we have gained much to have learned their names and their realms. Still others await identification.

However, some forty years of vitamin history now clearly suggests prevention, not healing, of deficiency disease as the primary goal to be sought. Before this could be practically attained by the synthetic route, it was necessary for the vitamins to become cheap, a result which could only come through expanding production. It is a matter of pride that thiamine production and pricing has to a degree set the pattern for those of other vitamins. The first kilo or two of the synthetic article sold for \$10 a gram which seemed very cheap by comparison with the natural substance in pure form which cost over \$300 a gram to produce even on a relatively large scale of operation. However, the price of synthetic thiamine swiftly declined to \$1 and then more slowly to a level of 16 cents in recent years when the annual volume of production in the United States has exceeded 50 metric tons.

In fostering the fortification of staple foods, we have had a great deal of help from the medical profession, but many fail to sense the difference between measures which tend to become self propagating and those which require persistent external pressure. The business man senses this immediately. Typically the doctor wants to incarcerate his patient in a hospital and there subject him to vari-

ous expedients under controlled conditions. If the findings are positive, publish the results and there you are, so he thinks. He is not greatly concerned whether or how soon the findings are put into general use. Only the physician with public health leanings or experience readily grasps the prime problem of correcting staple foods as they pass into the channels of trade. The correction of staple foods may be compared with the chlorination of water. One would scarcely round up a few patients in a hospital and give them chlorinated water as a test? The essence of both problems is the mass application of the measures. Can you do a thorough job when dealing with an entire population? Can efficiency, honesty and public acceptability be maintained year in and year out and what are the costs and the results when you do so?

The principal opposition to the so-called enrichment of bread and flour has, however, come from the perfectionists. This group which includes many nutritionists, physiologists and biochemists of high standing, argue with much formal logic that the proper correction for white flour and bread is to use the whole grain. Why take the vitamins out and then add the synthetic articles? The number of these objectors in the United States is not large and is gradually diminishing. There is a larger proportion of them in Canada and still larger in England.

If one were feeding dumb animals which are without means of effective protest, this might well be the answer. Humans, however, will normally eat what they like and raise Hell if deprived of it. Ninety-eight per cent of

the flour sold in the United States is white and substantial alteration of this fact will require many years and more persuasion than the nutritionists of the country can muster.

In the United States about 75 percent of the white bread and family flour has been enriched for the past three years or more. This is excellent progress since the practice began in 1941. In Canada the use of long extraction flour has been officially favored but according to the Canadian millers has actually been adopted to the extent of only about 7 percent of the output. In England conservation of wheat was vital during the war on account of shortage of ocean tonnage. The millers and bakers were encouraged, first by appeal and later by legal mandate, to make and to use long extraction flour comprising 85 percent of the grain instead of 72 percent. The success of the authorities with this measure in wartime predisposes many English scientists to believe that it can be maintained in peace. However, that remains to be seen. The British have done an amazingly good job of sustaining the nutritional adequacy of the dietary during the war. It has, however, been very monotonous and unattractive and still remains so. Dr. Tisdall of Toronto tells of the avidity with which Englishmen embarking for the United States during the war attacked the tasty white bread offered on shipboard.

The complete category of vitamins of the B group is not yet commercially and cheaply available. Protest has been raised that the addition of thiamine, riboflavin, nicotinic acid and iron misses some of the nutrients which whole wheat supply. This is true, but

do we fail to get adequate supplies of other B vitamins from other foods? There are five deficiency diseases which have been known for centuries, have acquired household names in all languages, and are still found, at least in mild forms, among American populations in recent times. Is it not good sense to eradicate these diseases by the most expeditious means available, especially since deficiency diseases traceable to lack of the other vitamins are still unknown in a practical sense. If they appear later, we may have the means to master them. Let us cross one bridge at a time.

The fear has been expressed that fortification of staples with synthetics will lead to indiscriminate fortification or other sophistication of all our natural foods. This fear was foreseen by the Food and Nutrition Board of our National Research Council in 1941. In a carefully elaborated and much discussed resolution it declared itself in favor of such additions only to those foods which are effective vehicles for distribution of a particular nutrient to a significant segment of the population. Specifically the following additions were endorsed and no other: vitamin A to oleomargarine, vitamin D to milk, iodine to salt and thiamine, riboflavin, nicotinic acid and iron to white bread, white flour and corn meal.

Enrichment of white bread and flour can only be regarded as cheap insurance for substantially the entire American people against deficiencies of the nutrients added. It costs Americans about 20 cents per capita and is worth it though it won't prevent cancer, falling hair or labor troubles.

The need for such insurance is indi-

cated by the widespread occurrence in clinical practice of conditions which respond to vitamin therapy. Statistically there is a certain probability of these deficiency conditions affecting individuals in every level of society but it is higher among low income people. Daily dosing with vitamin tablets would not have become so prevalent if there were not something in it. The truth lies somewhere between the panegyrics of the radio advertisers and the denunciations of vitamin purveyors by the iconoclasts. Vitamin tablets are harmless and we can safely leave it to the public to decide how much benefit it derives and how much it is willing to pay for them. Many scientists use them and feel that they benefit by them. It is folly to assume blandly that human diets are quite adequate without them. Manufacturers of animal feeds find it necessary to incorporate synthetics in order to get the best performances. Furthermore, let anyone who thinks his own diet quite adequate try feeding it to rats. From my own experience he is almost certain to encounter failure of reproduction in the second or third generation. How many human mothers are capable of nursing their babies? If resort to the bottle were prohibited, how much rise in infant mortality would result? The wiseacres of nutrition today may put themselves in the position of those of a generation ago who asserted that calories, minerals and an assortment of amino acids constituted a complete diet. It is wiser to await further experiment and experience before adopting a negative attitude.

Enrichment of corn meal is virtually unopposed because of the long

past association of pellagra with corn diets. Corn according to the latest evidence is not only low in nicotinic acid, the anti-pellagra vitamin; it is also low in tryptophane which seems to be a precursor of nicotinic acid in the rat. According to Wooley, corn also contains an antivitamin, that is a substance similar to nicotinic acid, which competitively fakes its role in an enzyme system but cannot do its work. Corn enrichment is progressing very slowly in comparison with wheat, simply because a large part of the corn meal of our South where it is a staple, is produced by thousands of small mills. It will take a long time to educate all those millers. This constitutes an excellent example of the fact that the organization of a food industry determines the feasibility of a particular public health measure far more than do the cold scientific facts about nutritional needs.

Beriberi is the oldest and most widespread of the deficiency diseases. It is particularly prevalent in the Orient where rice is the staple grain. There is a great deal of interest in the nutritional improvement of rice in the United States, largely as an outgrowth of bread and flour enrichment. Beriberi and white rice had become intimately associated in the popular mind. Under the impetus of the interest of the industry and without official pressure from government or nutrition organizations a large fraction of the rice produced here is now being improved either by parboiling or by artificial enrichment. Parboiling is an ancient traditional practice in India whereby rice is first soaked in hot water in the husk and then dried. This saves labor in handmilling, but we now know

also that during steeping the vitamins of the bran coats soak into the interior of the grain and under favorable circumstances are conserved to the extent of 50 to 75 per cent of the total.

I have recently returned from China and the Philippines where large scale experimental projects for the fortification of rice are being planned. A process such as parboiling which conserves the native vitamins seems the logical thing for the Orient but surprisingly it costs more than artificial fortification and particularly requires a very much greater initial investment where the climates does not permit reliance on sun drying as in India. It seems quite feasible to introduce artificial fortification for Asiatic cities and more modernized areas in the next few years. Low per capita costs of the order of 25 cents per annum make it possible. The process is cheapened very much by highly fortifying 0.5 per cent of the grain and adding this "premix" to 199 parts of ordinary white rice.

In more remote areas where introduction of a modern Western process would be difficult more primitive methods of milling tend to prevail and the bran is less completely removed. However, the use of primitive methods is steadily retreating. It has almost disappeared in the Philippines and in urbanized areas of China. Western rice milling machinery predominates throughout the lower Yangtse valley. Use of undermilled or brown rice is already a dead letter in areas where white rice is available in competition. Mayor K. C. Wu of Shanghai is an ardent advocate of brown rice, but admits he has had no success in promoting its use. Reactions of rice eaters

and those of wheat eaters reveal a remarkable parallelism.

The realist will ask what will happen to the already overcrowded populations of Oriental countries if by introduction of preventive medicine an Occidental death rate is superimposed on an Oriental birth rate. It is a valid and vital question which Oriental leaders must face more clearly than many of them have yet done. However, even the most realistic realist will scarcely openly advocate the deliberate perpetuation of disease as a limit on population. The only alternative solution is a confessedly somewhat remote one: namely, by introduction of scientific methods to expand production till a standard of living and of education is attained which brings with it an automatic check on the birth rate, such as we have seen in Western countries. One can take comfort in the fact that preventive medicine in general raises productive efficiency as well as, or even more than, the birth rate. India, for example, where the mean span of life is 27 years as compared with 60 in the United States, wastes her substance in rearing hordes of people only to have them cut off after relatively few productive years. In addition, it is conspicuously true of the deficiency diseases that they are rarely severe enough to kill. For the most part they merely impair efficiency throughout life.

With war clouds increasingly threatening our civilization, many scientific minds are straying from their studies of the physical world to problems of human relations. Among the most useful and least controversial instruments for good will among nations is the spread of public health measures and

the betterment of food supply among the less favored. Conquest of disease and famine, like love of children, is a common denominator for mankind. Stability of society demands satisfaction of hunger and a well-nigh universal sense of justice revolts at starvation for some amidst plenty for others. The resources of modern technology make readily possible the universal satisfaction of man's elemental needs for food if we can find means to effect reasonable distribution rather than allow plenty and want to exist side by side. This is the central theme of the

Food and Agriculture Organization of United Nations ably led by Sir John Orr. It appeals to me tremendously though I prefer to rely on freedom of trade rather than governmental compulsions to achieve it. At all events I am happy at the prospect that synthetic vitamins may play a part in equalizing the adequacy of food supply for mankind. For the long pull the chemical factory will inevitably supplement the farm, as well as use the products of the farm, in averting Malthusian disaster to the race.

Heart Beats In Chemicals

► FRAGMENTS of embryo chick heart tissue can be kept alive and pulsing for as much as six weeks in a solution of exactly known chemical composition. Other embryo tissues also have been maintained in growing condition for somewhat longer periods by Dr. Philip R. White of the Institute for Cancer Research, Philadelphia.

This represents the first step toward growing animal tissues indefinitely under fully known and controllable conditions, something that has already been accomplished on plant tissues by Dr. White and several other workers.

The "immortal" chick heart cultures, for which the late Dr. Alexis Carrel won popular renown, were grown in fluids taken from animal bodies. Since the makeup of these fluids is very imperfectly known, important details of the biochemistry of growth must also remain unknown.

It is the determination of Dr. White and his co-workers to duplicate with

animal tissues the success they have already had in plant tissues, thereby opening the road toward better knowledge of all growth processes, including the malignant ones that cause cancers.

The nutrient solution used contains dextrose, several mineral salts, 11 vitamins and 12 amino acids. He stated candidly that "this is a shotgun mixture which will have to be studied in more detail, which can probably be simplified, and may ultimately need to be enlarged."

One of the things that should be possible, once a really successful animal tissue culture has been developed, capable of sustaining life and growth indefinitely, is a study of the basic biochemical differences between normal and cancerous tissue. Specimens of each kind, put into the same fluid and kept under identical conditions, should express the differences in their natures by differences in what they do with the food materials with which they are supplied.

Chemical Magic

Pour Rainbow From Clear Water

by JOSEPH H. KRAUS

► ANY RAINBOW color, selected by one of your friends, can be poured from a transparent glass carafe that has been properly prepared for this trick. Clear water in the container takes on color as it passes from the mouth of the decanter. While water poured into several glasses may be of different colors, water in the container remains clear and transparent.

For best results you should get a glass water container with fluted lips similar to the one shown in the diagram. These are available in five- and ten-cent stores. If such a water vessel cannot be obtained, get a fluted flower vase. Either is ideal for the experiment.

A set of water colors, such as a child's paint set, can be used to give the desired tints. Photo water colors, usually available on sheets of paper coated with aniline dyes, are excellent because of their intensity and ready solubility. You can get them from photo supply stores. You will want all the colors of the rainbow—violet, indigo, blue, green, yellow, orange and red.

To prepare the demonstration, let a drop of water fall on a one-inch square cut from a photocolor folder. After it has picked up as much of the dye as possible, add two drops of glycerine. Mix the glycerine and water thoroughly to give you a thick, colored glycerine solution. Prepare each of the rainbow colors in this way.



SS

Fill With Water First

After filling your glass container with clear water, at equal distances in the flutes of the water container let fall drops of colored glycerine. A brush will help in getting just the right amount. Make sure that you apply only enough colored glycerine to hold in place. Too big a drop will roll down the groove and contaminate the clear water, spoiling the trick.

When all the colors have been applied, set the carafe at the center of a tray and arrange seven empty glasses in front of it. You are now set for your demonstration.

Ask one of your audience to name any of the colors of the rainbow. After

he has chosen a color, ask him to select one of the glasses arranged on the tray. Give him the glass to examine. This lets you move around the table so you can grasp the carafe by the neck in such a way that the chosen color will point downward when you tip the container. This eliminates the need for turning the carafe in your hand before pouring.

Slowly tip the container. Water pouring over the colored glycerine will take on the color of the paint.

Call the attention of your spectators to the fact that the glass is perfectly empty and that the water in the carafe is absolutely transparent. Point out that the color change actually takes place as the water pours past the lip of the container. Your friends are less likely to guess how the trick works, however, if you do not draw attention to this last fact until near the end of your performance, preferably when one of the deeper shades such as red or violet is selected.

Oil From Oil Shale

► THE DESPERATE attempt of the Nazis to keep their war planes in the air was aided by improved methods of getting oil from low-grade oil shale, it is now revealed. The methods are now available to the American oil shale industry.

Hitler in the early war days depended on motor fuel and lubricants from the Romanian oil fields. When Allied bombing activities cut this supply, he turned to Estonia where oil from oil shale has been made for years. When Russia cut this supply, only the low-grade shale deposits of Wuerttemburg were left. These, by the new methods developed, produced oil in limited quantities in the closing days of the war.

The process, as carried out at the Portland Cement Works at Dotternhausen, is described in a report issued by the Office of Technical Services, U. S. Department of Commerce. The report is available to those interested.

In this plant, the oil shale was

heated in a Meier-Grelman retort. Steam, superheated to 800 degrees Centigrade, was passed horizontally through a downward-moving mass of crushed shale. Oil vapors and gases passed out the opposite side of the retort along with the steam to be later recovered. The remaining shale was usable as hydraulic lime, or for the manufacture of Portland cement when heat-treated and mixed with limestone and coke.

Oil-bearing shale is rather plentiful in parts of the United States and, in future years, may become an important source of fuel oil, gasoline and lubricants. Unless important additional deposits of natural petroleum are discovered, the day may not be far away. The situation is well-known here. The government, through the Bureau of Mines, has already established laboratories and pilot plants to develop efficient and low-cost methods for producing these essential products from the shale.

Kudzu, a common ornamental porch vine in the Southeast, is now widely used in soil conservation to protect slopes and gullies; it supplies a high protein pasture which cattle like.

Irritants Affect Skin More Than Stomach Lining

Chemicals and the Skin

by JANE STAFFORD

► IT WILL PROBABLY surprise you, as it did some physicians, to learn that the skin is more sensitive to irritating chemicals than is the lining of the stomach. The findings were reported by Drs. Stewart Wolf and Harold G. Wolff, of the New York Hospital and Cornell Medical College, to the New York State Medical Society. They were made on a patient with an otherwise normal stomach which had a large opening, called a fistula, to the outside of his body. Through this opening, the doctors are able to see what goes on inside the stomach.

Alcohol, both 50% and 100%, caused a moderate reddening when applied to the skin of the forearm, but caused no change when rubbed lightly on the lining of the stomach. Mustard water, hydrochloric acid and the alkali, sodium hydroxide, caused reddening, swelling, tenderness and blistering when applied to the forearm. But when rubbed lightly on the lining of the stomach, these same substances caused only reddening.

Such so-called stomach irritants as digitalis, ammonium chloride, ferrous sulfate, sulfa drugs and aminophyllin were not irritants at all, the physicians found.

The layer of slimy mucus which invests the stomach at all times protects it entirely from the action of irritants which redden and blister the skin, the doctors report. Production of this

mucus is stimulated by caustic chemical agents or by mechanical irritation. It seems to protect the stomach in three ways: 1. by presenting a slippery surface to any harmful substance; 2. by its ability to neutralize acid; and 3. by its ability in an overwhelmingly acid medium to change its physical state, precipitate and form an opaque, insoluble membranous insulating layer over the delicate cells of the stomach lining membrane.

Drugs like ipecac which induce vomiting do not act on the stomach but bring on nausea only after they have reached the intestines.

Carbon Tetrachloride Poisoning

Some of you may be familiar with carbon tetrachloride in the cleaning fluid you use at home for removing spots from clothing or similar jobs. It is also used as a metal degreaser, rubber solvent and fire extinguisher and has many other industrial applications. It is nonflammable, but must be properly handled to avoid getting poisoned.

The poisoning may come through a single brief exposure to a high concentration of the vapor. Or it may come from regular daily exposure to low concentrations. Getting the liquid on the skin repeatedly can cause poisoning symptoms and some persons are allergic to it and will get sick from a single contact with it. It can also poison if accidentally swallowed.

Redness, roughness, chapping and infection of the skin, headache, nausea and vomiting, dizziness, disturb-

ance of vision, a feeling of fullness in the head, and mental confusion are among symptoms of poisoning from this chemical, as given in a report in the Journal of the American Medical Association.

Breathing may stop and the victim die, in case of high vapor concentration, if he is not promptly removed to a safe area where there are no carbon tetrachloride vapors. A person with symptoms of nausea, dizziness, headache or unconsciousness who has been exposed to the vapor should be gotten into fresh air quickly and kept warm and quiet. If breathing has stopped, artificial respiration should be given. If the patient is conscious, hot tea or coffee may be given as a stimulant. Alcohol and epinephrine (adrenalin) should never be given to a person overcome by carbon tetrachloride.

If carbon tetrachloride splashes into the eyes, they should at once be washed with large amounts of water for at least 15 minutes. If the liquid spills on the skin, wash thoroughly with mild soap and warm water and then apply an ointment containing petrolatum or lanolin. If the liquid has been swallowed, induce vomiting by giving the patient a glass of mustard water, lukewarm salty water or warm soapy water.

Since carbon tetrachloride poisoning can be fatal and may have serious after-effects in those who survive a physician should be called even if the patient seems to respond to first aid measures.

Cold-Wave Solution

If you get a cold-wave permanent in a beauty parlor or give one to yourself at home, you should see that certain precautions are followed to protect

your skin. Most cold-wave solutions contain ammonium thioglycollate which is derived from thioglycollic acid. Both these chemicals, industrial hygiene authorities of the U. S. Public Health Service state, are primary skin irritants, especially in strong concentrations. They give the following advice on a safe use of these solutions:

Wear Rubber Gloves

Beauty parlor operators whose hands come in continued contact with its irritant action when they give cold-wave treatments should be protected by wearing rubber gloves.

Women getting cold waves in beauty parlors should have the forehead and face well protected either by towels or grease so that the first or reducing solution (ammonium thioglycollate) will not touch the skin of the face and forehead. The solution should be carefully applied to the hair so that a minimum amount touches the scalp.

Cold-wave solutions sold in stores to be used at home usually are not as strong as those sold for use in beauty parlors and there is less likelihood of developing a dermatitis from them. Nevertheless, the user should protect herself in the same manner described above for those getting cold waves in beauty parlors. The use of cold-wave solutions for 15 or 20 minutes on the hair should be followed by the use of water to wash the solution off the hair.

If the cold-wave solutions are used with the proper precautions described above they will not harm the hair any more than other methods of permanent waving. For the protection of the operator and the patron, explicit directions should be printed on bottles of cold-wave solutions.

Summaries of Some Recent
U. S. Inventions Recognized

Patented Ideas In Chemical Fields

One of the essentials of patenting is that the public may read and purchase for a small fee the patent record. A quarter (not in stamps) will purchase a patent specification from the U. S. Commissioner of Patents, Washington 25, D. C. Order by number.

► A WAR-BORN invention, designed to meet a Government demand for copper wire coated with natural rubber that would not deteriorate quickly, won for D. J. Miller of Akron patent 2,411,284, rights in which he has assigned to American Anode, Inc.

Though often found together, copper and rubber are really not good friends. The copper rots the rubber, and sulfur in the rubber attacks the copper. So in the past the wire has been pre-tinned, paper-wrapped, or otherwise treated to separate it from the rubber.

In Mr. Miller's invention, the wire is first coated with a powder consisting of zinc nitrate, calcium nitrate and a wetting agent. Then it is run into a latex bath and the rubber deposited directly on the wire. After vulcanizing, the rubber surface is treated with chlorine to give a smooth, non-sticky finish.

Two Ribbed Typewriter

► A TWO-RIBBONED typewriter obviates the necessity for using carbon paper sheets. Each ribbon has its own pair of spools, one outside the other. Patent 2,411,402, issued to F. O. Wendt

of Copiague, N. Y., has been assigned to the Royal Typewriter Company.

Better Castings

► BETTER castings can be obtained by keeping air away from molten metal during the pouring, claims Carl Wessel of Chicago, recipient of patent 2,411,176. He uses a closed ladle, pre-heats it before filling, and plays flame over the surface of the molten metal to keep the air away.

Increase Yeast Vitamin

► INCREASE by at least 50% in the vitamin contents of brewer's yeast by keeping it on a limited food supply and at relatively low temperature for a week or more is claimed by Ben Maizel of Chicago in patent 2,411,445, which he has assigned to the Vico Products Company.

Color Matching

► COLOR-matching, important in a thousand industries all the way from hosiery to house-paint, has the guess-work taken out of it by a device on which U. S. Patent 2,411,741 was granted to J. L. Michaelson of Schenectady, a General Electric engineer. With it you do not attempt to match the colors directly, but fit two curves that are the electrical expressions of the color standard and the sample.

A beam of light is turned on standard and sample in rapid alternation, by means of a moving mirror. Light reflected from the two surfaces is caught by a train of mirrors and passed through an analyzing prism into a

photocell. Current from the photocell, suitably amplified, is passed into a cathode-ray tube, tracing the curves on its viewing surface for comparison.

Formaldehyde Process

► Dr. Thomas K. Sherwood of Wellesley, Mass., has made an improvement in the process of manufacturing formaldehyde, important as a disinfectant and as an ingredient of plastics, out of air and natural gas. By raising the working temperature, he completes the process in a small fraction of the time formerly required. The formaldehyde vapor is then condensed by contact with a cool formaldehyde solution. Patent 2,412,014, covering this process, is assigned to Godfrey L. Cabot, Inc., of Boston.

Lead Cleaned By Chlorine

► PATENT 2,411,940, granted to W. W. Shropshire of Chicago and assigned to the International Smelting and Refining Company, is a chemical process that cleans smelted lead of a contaminating half-percent of zinc by running in chlorine at several points along a long flow-bath through which the melted lead passes. This takes out the zinc in the form of zinc chloride.

Kills Nematodes

► A new chemical for killing nematodes, which are plant-destroying lower worms that infest many soils, is known as 1,1-dichloropropene-2. On this, patent 2,411,566 has been granted to Dr. T. W. Evans of Oakland, Calif., a Shell Development Company chemist.

Refrigeration for Milk

► A REFRIGERATING showerbath for milk cans and similar containers has the cooling liquid recirculated through

a mechanical chilling unit, and kept constantly drizzling over the cans as they stand in a closed cabinet. This invention of A. F. McMahon of Oak Park, Ill., is covered by patent 2,411,833.

Purifying Alumina

► USE of hydrofluoric acid to purify alumina is a step in the production of aluminum. The alumina is subsequently leached with another acid. This process is protected by two patents: No. 2,411,806 to A. H. Riesmeyer of Collinsville, Ill., and W. H. Gitzen of Beltsville, Ill., No. 2,411,807 to Mr. Riesmeyer alone. Both patents are assigned to the Aluminum Company of America.

Flaming Candles

► A NEW kind of electric candles, slim, transparent tapers, seem to be alive with dancing flame through their whole length.

The effect is achieved very simply. A candle-shaped glass tube filled with a volatile liquid is set into a socket, its bottom touching the top of a small electric lamp. Slight irregularities purposely molded into the bottom form foci or starting-points for streams of vapor as the liquid boils; a small empty space at the top serves as a condenser. The lamp's heat causes the boiling, its light makes the tube glow and flicker as the ribbon-like vapor streams rise through the liquid.

U. S. patent 2,412,379 has been granted on this device to Abraham Abramson of New York, who has assigned his rights in it to the Raylite Electric Corporation.

Salt Well Brines

► BROMINE and iodine are obtained from salt-well brines in a process on

which patent 2,412,390 has been granted to John Cranston of Ironton, Ohio. Bromine is driven out by addition of chlorine; a current of air carries it into a solution of ferrous bromide which it raises to the ferric state. More chlorine and heating releases the bromine again for liquefying; still more chlorine drives out the iodine.

Synthetic Rubber

► A SYNTHETIC rubber resistant to both cold and solvents, hence useful in airplane safety tanks, is covered by patent 2,412,214, assigned by its inventor, A. H. Gleason of Westfield, N. J., to the Standard Oil Development Company. It is a copolymer of butadiene or some similar compound with acrylonitrile or one of its chemical relatives.

Electrical Insulators

► A GROUP of patents, 2,412,373 through 2,412,376, has been issued to a Swedish inventor, A. R. Wejnarth of Stockholm, on a material for electrical insulators that is at once very hard and resistant to both heat and chemical action. It consists of a sintered mass consisting mainly of silicon carbide, with the addition of nitride, carbide, silicide or boride of molybdenum, chromium, titanium or vanadium.

New Silicone

► A NEW water-repellent of the silicone class is protected by patent 2,412,470, assigned by F. J. Norton of Schenectady to the General Electric Company. It consists of a mixture of trimethyl silicon chloride and silicon tetrachloride.

Charcoal Protects Apples

► GAS MASKS of World War I vintage have contributed an idea that may be the means of saving apples in storage from ripening too rapidly.

Most important single item in the gas-mask canister was activated coconut-shell charcoal, whose myriad minute crevices offered a great internal area on which the molecules of the poison gases were adsorbed. Prof. R. M. Smock of Cornell University uses the same basic idea in apple storage houses, drawing air through canisters of coconut-shell charcoal with suction fans to remove the ethylene gas that stimulates apples to premature ripening. There is no way of preventing ethylene from getting into places where apples are stored, for the

apples themselves generate it in the ripening process. If a few apples start ripening up, the ethylene they give off starts others, until finally the whole warehouseful of apples may be in a mad chemical race toward precocious maturity. This premature ripening in storage is usually accompanied by widespread occurrence of scald, one of the worst types of apple spoilage.

As soon as Prof. Smock's method can be placed on a full-scale commercial basis it should result in large savings to apple growers and handlers. Cost of de-ethylenizing of storage-house air is reckoned at about one-half cent per bushel.

How Ring Compounds Add Side Chains

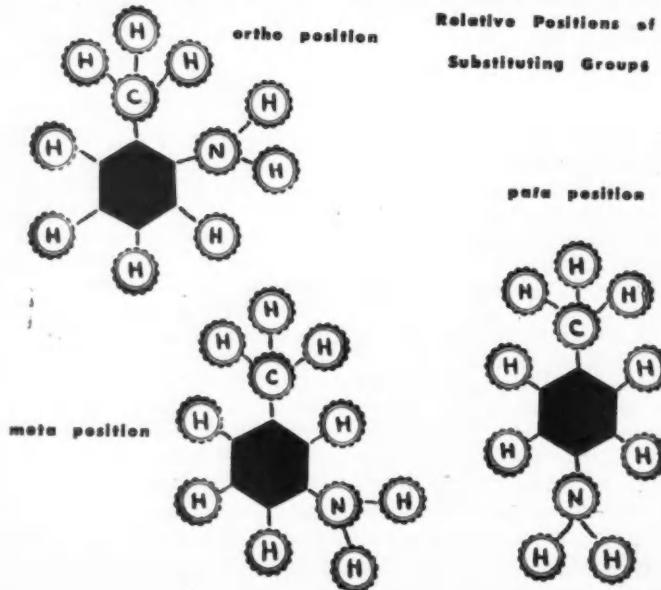
The Benzene Derivatives

► THE BENZENE RADICAL, C_6H_5 , forms compounds in much the same way that CH_3 or any other hydrocarbon radical does. Its ring structure, however, gives rise to special kinds of isomerism when more than one hydrogen atom is replaced. This is illustrated in the accompanying diagram by the case of a methyl group CH_3 , replacing one hydrogen atom and an amino group, NH_2 , replacing another.

There are three possible positions for these substituting groups relative to each other. When they are attached

to adjacent carbon atoms they are said to be in the ortho position. If they are joined to the next-but-one atoms, they are in the meta position. If the carbon atoms that hold them are diametrically across the ring from each other, the groups are in the para position. Like other isomers, these compounds show differences in their crystalline structure, melting and boiling points, and such other characteristic properties.

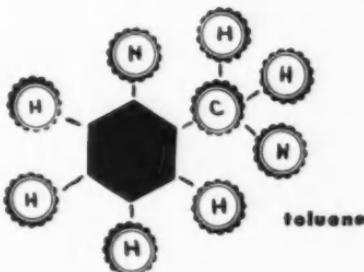
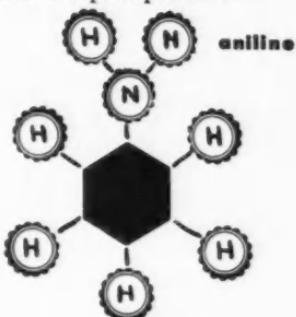
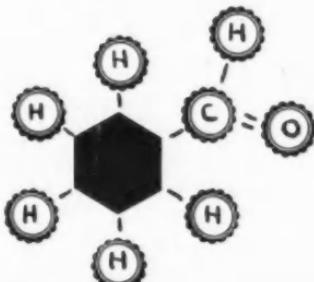
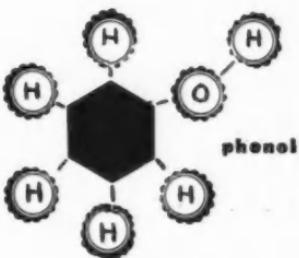
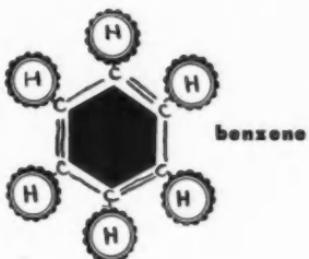
On the other hand, there is no such difference in compounds containing



only one substitution group, which is evidence that all positions in the ring are the same, or, in other words, that the ring structure is completely symmetrical.

The constitution and names of some of the common mono-substitution

products of benzene are also shown in the accompanying diagram. Each is the archetype of a series of compounds, and all these compounds are capable of many series of modifications by other radicals in the ortho, meta and para positions.



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MISTRY

Total Chemical War On Insects

► TOTAL chemical war of extermination against whole species of insect pests is in prospect.

With such weapons as DDT and benzene hexachloride in our hands, and even more potent ones now being forged, it should be possible not merely to control or abate them but to wipe them out entirely. In a recent address, Dr. Clay Lyle of Mississippi State College reversed the defensive and even defeatist line long held by many entomologists and sounded the call to counter-attack.

Possibility of completely eradicating such plagues to comfort and menaces to health as houseflies and lice is no mere enthusiast's dream, he pointed out, for highly effective campaigns have been waged with such weapons as we have had in the past. The cattle fever tick, which once cost uncounted millions in livestock losses, has been virtually exterminated in the continental United States. A one-year

"blitz" against the Mediterranean fruit fly in Florida blasted this dread enemy off its beachhead before it could get farther inland.

Dr. Lyle picked out the housefly as the most vulnerable of our present widespread pests to a determined "get-em-all" attack. With easily obtained public cooperation, a state-wide campaign was waged last summer in Idaho. It was so successful that when a student at the State University wanted a few flies for experimental breeding purposes he could not trap a single one near a slaughterhouse or close to a collection of garbage cans. He finally found a few of the now rare insects in a remote farmhouse.

"There should be many situations before the end of 1947," Dr. Lyle declared, "where a city or county health officer will be asking anybody who has seen a fly to report it. After which a spraying crew will visit the property to locate and destroy breeding sources."

Answers to Chem Quiz on Page 27

Benzene— C_6H_6

Benzine—a light gasoline fraction.

Benzoin— $C_6H_5CHOHCOC_6H_5$

Fluorene— $C_6H_4CH_2C_6H_4$

Fluorine—one of the elements.

Hexane— $CH_3(CH_2)_4CH_3$

Hexene— $CH_2:CH(CH_2)_3CH_3$

Hexyne— $HC:C(CH_2)_3CH_3$

Ketene— $CH_2:CO$

Ketine—



Ketone— CH_3COCH_3

(dimethyl ketone, acetone)

Luminal—phenobarbital

Luminol—



Populin— $C_{20}H_{22}O_8$

Popular—what this quiz will not be if we put in too many such puns.

Surface Tension Modifiers Make Science Club Demonstration

Making Water Wetter

► EFFECTS of wetting agents on surface tension of water makes an interesting project for members of the chemistry club. Experiments and demonstrations can be prepared which will fascinate an audience while they illustrate important scientific principles.

First demonstrate surface tension.

This is the phenomenon that appears to give water, and other liquids, an invisible elastic skin which tends to contract to the smallest possible area.

Keep adding water carefully to an already full glass. Notice that you can heap the water up about an eighth of an inch above the mouth of the glass before it begins to flow over.

Fill a glass tumbler level full of water and drop coins in edgewise. Notice how many you can drop in before the water overflows.

A needle or razor blade will float on water in spite of the fact that steel is about 8 times as heavy as water, volume for volume.

Place a brand-new razor blade carefully on the surface of the water in a glass. Note, it will float.

This feat is more difficult to repeat with a needle. Balance the needle on the tines of a dry fork and let it roll horizontally onto the water surface from a height of about one-eighth inch. Note this also floats.

Because of complex molecular forces, the uppermost layer of the

water resembles a stretched sheet of rubber. It is capable of supporting light objects providing they are "unwettable." A new needle or blade is enveloped in an imperceptible film of oil which helps keep it resting on the surface. The strong surface film of water is bent downward by the steel blade but is strong enough to support it.

You have probably watched the small Velia bug, better known as the water strider, skate across the surface of shady pools in the summer. How this curious insect manages to "walk" on water has mystified many people. It can perhaps best be explained by surface tension. If you observe the Velia bug you will note that its legs scan the surface but don't break through.

Wetting agents are substances which are added to surface coatings, water, or oils to increase spreading and penetrating action, to dye solutions to aid penetration and increase levelness of color, to adhesives to improve the contact and hence aid adhesion, and to regulate the characteristics of precipitates.

Industrial concerns have dramatized advertisements of wetting agents the better to portray them to the public. Club members may duplicate these or devise their own spectacular demonstrations. For example: A live duck may be made to sink if it is placed in a tank of water containing a good wetting agent or if it has been given

an advance bath with the wetting agent. Scientifically speaking, the wetting agent penetrates the water-repellent coating of oil which normally traps air beneath the feathers and keeps the duck afloat, thus the duck sinks.

Wetting agents are chemical molecules composed of two different parts—one which draws the agent into the water, the other which tends to leave the water and attach itself to or dissolve in an oil. This class of chemicals is effective in bringing about improved wetting.

"Soapless Soaps" to make water wetter come in liquid, powder and solid form, under many trade names and are very popular with the housewife because they help make cleaning easier. The antagonism between water and greasy dirt is destroyed. The wetting agent gets under the dirt and literally lifts it up, holding it in suspension, and allows it to be rinsed away.

A simple experiment that will show how wetting agents work is to pour a little water on a polished surface and see how it sticks together in droplets because of surface tension. Add a few drops of wetting agent, the water spreads quickly in a thin film and penetrates the tiniest opening.

The tendency of soap to combine with calcium ions in the water to form a useless, insoluble precipitate creates the problem of "hard water" and how to wash in it. Older methods of water softening aimed to get rid of the calcium ions. Newer detergents operate in several ways, such as, to avoid forming insoluble compounds, to make foamy suds with other materials than conventional soap, and to use wetting agents to emulsify grease. Club members may collect samples of different kinds of household cleaners and devise tests to show how they accomplish these aims.

A-Bomb Assembler on Commission

► THE MAN who directed the assembly of the world's first atomic bomb is one of the five members of the atomic energy commission. He is Dr. R. F. Bacher, the Cornell University physicist who served as head of the bomb physics division at the Los Alamos Laboratory of the Manhattan District.

Putting together the heart of the bomb that exploded in the New Mexico desert July 16, 1945, was Dr. Bacher's job. Here's the way the official War Department story of that first bomb describes the new commission member's job:

"Final assembly of the atomic bomb began on the night of July 12 in an old ranch house. As various component assemblies arrived from distant points, tension among the scientists rose to an increasing pitch. Coolest of all was the man charged with the actual assembly of the vital core, Dr. R. F. Bacher, in normal times a professor at Cornell University."

Recently a scientific adviser to Bernard Baruch, the U. S. representative to the United Nations Atomic Energy Commission during 1946, Dr. Bacher is the only atomic scientist among the five men named by the President.

Bomb Project Equipment Used Silver From U. S. Treasury

Silver Put to Electrical Use

► INDESTRUCTIBILITY of the elements was demonstrated at the very center where large-scale transmutation was first accomplished, according to information recently released. Hoarded silver was put to practical use instead of lying idle, and spilled uranium was recovered from the mop rags.

Silver from the U. S. Treasury's stocks was used instead of copper for electrical conductors in the atomic bomb-making equipment of the Manhattan District during the war, the engineer who headed the groups responsible for the preliminary construction of technical facilities at Oak Ridge, Tenn., revealed.

With copper urgently needed for ammunition production in 1942 and 1943, 14,000 tons of silver valued at \$400,000,000 were withdrawn from Treasury stocks, processed in copper rolling mills and silver-soldered into conductors for use in the atomic bomb work, A. C. Klein, Engineering Manager of Stone and Webster Engineer-

ing Corporation, Boston, Mass., writes in a recent issue of *Army Ordnance*.

The value of the silver was approximately equal to the cost of constructing both the electromagnetic plant and the town of Oak Ridge.

Describing problems of constructing the atomic bomb facilities, Mr. Klein said that magnets 100 times as large as any previously built were constructed. These huge magnets, 250 feet long and using thousands of tons of steel, were capable of wrenching tools out of a workman's hands.

In working with uranium it was necessary to salvage every particle of material enriched with U-235, and even special laundries were used to save valuable drops of uranium solution that splashed onto workers' clothes. Small laundries in individual buildings washed the clothes, and the uranium was recovered from the wash water. Discarded uniforms and clothes were burned in a large incinerator, and the ash was dissolved in acid and treated to recover the valuable element.

Plastic Insulator

► A UNIQUE PLASTIC with unusual electrical properties has recently been developed by the Du Pont Company. Its trade name is "Teflon." It is unharmed by temperatures up to 575 degrees Fahrenheit and withstands every known solvent. They claim that it is an excellent insulating material for the ultra-high frequencies required by

radar and television, having extremely low dielectric loss even at frequencies up to 3,000 megacycles. It does not dissipate the electric power as do most organic insulators when subjected to high-frequency currents. It is an excellent material at extreme low temperatures and may be flexed without cracking at 150 degrees below zero.

**Lightest Element Studied
For Effect as Steel Alloy**

Hydrogen In Steel

by J. B. AUSTIN

Assistant Director, Research Laboratory, United States Steel Corporation of Delaware.

► IT HAS LONG been suspected that an excessive hydrogen content was in some way associated with the presence of certain imperfections occasionally observed in rails or large forgings which are rejected for severe service, and for the occasional reduced ductility of sheet or wire after pickling in acid to remove scale. To establish the truth or falsity of these suspicions, and to find suitable remedies has, however, been difficult, because hydrogen, considered as an alloying element, is unusual in so many respects. This very puzzling question is now being actively investigated by scientists of United States Steel Corporation and its subsidiary companies.

Hydrogen is never added intentionally, but it gets into steel more or less inadvertently. It is present in extremely small concentration by weight (usually less than 0.001%). There is no standard analytical method by which the hydrogen content may be determined accurately. Hydrogen alone among the alloying elements diffuses through iron at a measurable rate at room temperature or slightly above; hence the hydrogen content of a given piece of steel may decrease appreciably on standing. In spite of these difficulties, definite progress has been made in improving the quality and performance of steel products suspected of being influenced by the presence of this gaseous element.

Hydrogen dissolves readily in iron; the solubility increases with temperature and with hydrogen pressure, and is much greater in liquid than in solid iron or steel. Moreover, in dissolving hydrogen apparently dissociates so that it is atomic rather than molecular. In fact, molecular hydrogen appears unable to diffuse through solid iron.

Expressed in terms of weight per cent, the amount of hydrogen present in steel seems almost negligible in comparison with that of other alloying elements, but this may be misleading, largely because of the fact that the atomic weight of hydrogen is so small. A more informative basis of comparison is the number of atoms of alloying element present, since the number of hydrogen atoms corresponding to 0.001 per cent is the same as the number of carbon atoms when the carbon content is 0.012 per cent or the number of tungsten atoms for a tungsten content of 0.18 per cent. On this basis, 0.001 per cent hydrogen is by no means negligible.

Hydrogen may enter the steel in many ways during the process of steel making. It may be picked up directly from furnace gases or by reaction with any moisture, in the raw materials or elsewhere, with which the steel comes in contact during melting, refining or pouring. The hydrogen content of molten steel may thus become

quite high. Most of this is given off when the steel solidifies, although if solidification is rapid, an appreciable amount may be unable to escape and remains trapped, thus becoming supersaturated in the solid steel.

If the solid steel cools slowly, this supersaturation is relieved through diffusion of the excess hydrogen out of the metal, but if cooling is so rapid that there is not sufficient time for diffusion, the supersaturation increases to build up a pressure which may eventually rupture the metal locally. In all cases the best remedy yet devised appears to be holding at a relatively high temperature followed

by slow cooling, so as to permit the excess hydrogen to diffuse out.

Under some conditions, an excessive quantity of hydrogen may also be picked up during pickling in acid to remove rust and scale with a consequent loss of ductility in the pickled product. This loss of ductility is most marked when the steel is in the cold-worked condition, but the effect may be largely overcome by heating the metal at relatively low temperature after pickling to facilitate escape of the hydrogen by diffusion outward. Hydrogen embrittlement is also observed occasionally in welding if any water vapor is allowed to come in contact with the hot metal.

Molybdenum Cause of Sickness

► A "WHODUNIT" of nature—molybdenum poisoning which plays havoc with dairy herds in a 400-square-mile area of California—is under study by scientists in the University of California College of Agriculture.

An overabundance of molybdenum in pastures of the area has been shown by recent studies to be the cause of the disease, which develops slowly. Cattle are made ill only after weeks of feeding in the contaminated pastures. They become emaciated and anemic, and their coats fade.

Young animals are more seriously affected than older ones, and dairy cows suffer more than beef animals. Swine, horses and sheep are little affected. The same disease has been

found in England, where it is called "teartness."

Drs. Harold Goss and J. W. Britton, animal scientists in the College of Agriculture, report that the area involved is largely territory in Kern County which is an old bed of the Kern River. The land is undermined by decomposing swamp vegetation, and water tables are at some points within three feet of the soil surface. The two scientists indicate that this peculiar history of the area may be the cause of the accumulation of molybdenum in the pastures.

Solution of the mysterious malady, which has caused the abandonment of several dairies in the area, is occupying the time of scientists in four divisions of the College of Agriculture.

Whenever vegetables are subjected to water or steam treatment in cooking they lose some of their water-soluble vitamins.

**Steel Making Minerals
Shown on Back Cover**

Gems of Steel

So many unusual metals go into the making of special steels that the list of minerals steelmakers use is long and the samples make an interesting display of colors and textures. Although cropped a little at the sides, the picture on the back cover shows all the minerals listed here, and the key at the right will enable you to spot them. Both the photograph and the list of minerals are by courtesy of the publication "Steelways."

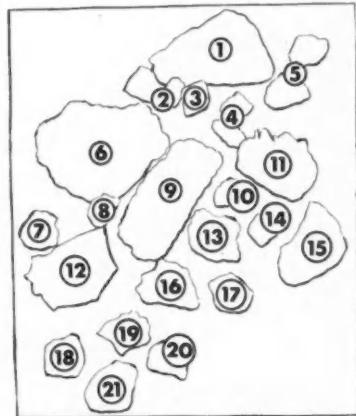
1, 6 Fluorite—More commonly known as fluorspar. Used as a flux or slag forming material. Makes slag more fluid. Principal U. S. sources: Kentucky and Illinois.

2 Quartz—More commonly known as silica. Used as a refractory in both brick and gravel form; principally in blast furnace and open hearth furnace linings. Major steel industry sources: Pennsylvania, Wisconsin and Alabama.

3 Calcite—More commonly known as limestone. Used as a flux in the manufacture of pig iron and steel. Principal U. S. sources: Pennsylvania, Michigan, West Virginia and Illinois.

4, 7 Dolomite—Used as a refractory in the steel industry principally for the bottom and sides of open hearth furnaces. Found in many sections of the United States.

5 Rhodochrosite—Ore of manganese. A metal which, next to iron, is the most important element in steel



making. Assists in ridding the steel of harmful impurities and imparts special characteristics of hardness and abrasion resistance. U. S. sources negligible. Principal foreign sources: Union of South Africa, India, Brazil, the Gold Coast, Egypt and Cuba.

8 Molybdenite—Source of molybdenum. Used in the steel industry to stabilize stainless steels, to harden engineering steels, and to prevent undue softening of steels at temperatures up to 1000° F. Principal U. S. sources: Colorado, Arizona, New Mexico and Utah.

9, 16, 17 Hematite—Most important American ore of iron. Name derived from the Greek word meaning "blood," referring to its typical red color. Principal U. S. sources: the

Lake Superior region and the Birmingham region of Alabama.

10 Carnotite—An ore of vanadium. U. S. sources: Colorado and Arizona. Named after A. C. Carnot, 19th Century French inspector general of mines.

11 Manganite—Another ore of manganese.

12 Vanadinite—Source of vanadium. Used in the steel industry to rid steel of harmful impurities, to increase tensile strength, and to increase ability to resist shock and abrasion. The principal U. S. sources: Colorado and Utah.

13 Limonite—An ore of iron. Name derived from the Greek word meaning "meadow," referring to its appearance in earthy or compact masses as bog-ore in meadows and marshes. Principal U. S. sources: western New England, southeastern New York, northern New Jersey, central Pennsylvania.

14 Cobaltite—Source of cobalt. Used in the steel industry in the manufacture of high-speed steels and magnet steels (high speed steels retain their cutting edge when the steel is red-hot). No known commercial sources in the U. S. Principal foreign sources: Canada, Rhodesia, French Morocco, Belgian Congo. Name comes from an old alchemist term, applied particularly to cobaltite and smaltite, both of which contain arsenic. They were called "kobold," meaning "goblin," by the Saxon miners.

15 Rhodonite—Ore of manganese.

Name derived from the Greek word meaning "a rose," referring to its common occurrence as cleavable to compact masses with rose-red color.

18 Nickeliferous pyrrhotite—Source of nickel. Used in the steel industry in the manufacture of stainless steels, alloy steels to be subjected to low temperature, general engineering steels, and steels which do not expand or contract materially when subjected to heat or cold. Principal supply from Canada.

19 Scheelite—Source of domestic tungsten. Used in the high-speed steels and magnet steels. Principal U. S. sources: Nevada, Idaho and California. Better known is wolframite, major source of tungsten found largely in China.

20 Ilmenite—Source of titanium. Used in the steel industry as a scavenger to rid steel of harmful impurities and to stabilize or prevent intergranular attack by corrosive media of stainless steels. Principal U. S. sources: Florida, Virginia, Arkansas, New York, California and Wyoming.

21 Chromite—Source of chromium. Used in the steel industry in the manufacture of stainless and heat-resisting steels, and to produce hard steels for bearings, gears, pistons, dies, etc. Principal U. S. sources: Montana, California, Alaska, Foreign sources: southern Rhodesia, the Philippines and Turkey. Name derived from Greek word meaning "color."

A copper sulfate plant is planned in Canada at a cost of \$500,000; Canada imported nearly 10,000,000 pounds of this chemical in 1943, approximately 80% of it from England and 20% from the United States.

Hobby Established as a Pastime
Becomes Memorial to Young Scientist

A Boy and His Work

► READERS should know how the following article happened to be written. As an aftermath of the untimely death last summer of a scientifically talented boy, the boy's mother faced the problem of putting his carefully assembled laboratory equipment into the hands of someone who could make appropriate use of it. The brother of the boy's history teacher is Dr. Byron C. Brunstetter, a biochemist in the U. S. Department of Agriculture.

Dr. Brunstetter has a private laboratory and was interested in further equipment. He found to his surprise that John's laboratory work was so advanced that the chemicals and apparatus John used were entirely suitable for his purposes. After a study of John's laboratory, Dr. Brunstetter feels that an account of its unique features should be an inspiration to those who feel hampered, in attempting to experiment, by lack of space.

As one of the forty winners of the Fifth Science Talent Search, conducted by Science Service in 1945-46, John Taylor Hopkins IV, aged 17, was awarded one of the Westinghouse Science Scholarships. His research project was on diazotization of various organic compounds. He had car-

ried on his chemical experiments in the apartment where he lived with his mother in Washington, D. C. He was graduated from Roosevelt High School in Washington in February 1946, and enrolled in the George Washington University. Late in the summer of 1946 young Hopkins was struck and killed by lightning while on a vacation trip in Florida. This tragedy ended a very promising chemical career. The author of the following article feels that one way in which John's personality and achievements can continue to make themselves felt is in this description, from the professional point of view, of how a lad in his eighteenth year solved the problem of doing advanced research in most unlikely surroundings.

Those of us who knew John remember him as the charming lad pictured here with the exhibit he set up for the Science Talent Institute hobby show. To Dr. Brunstetter, whose only acquaintance with him is through his laboratory, he was a serious fellow worker. Hence the author's insistence, in the following account, in spite of mild argument by the editor, on referring to this talented boy as "Mr. Hopkins."

► THE APARTMENT KITCHEN where the late John Taylor Hopkins IV carried on researches in advanced organic chemistry. Note the filtration equipment attached to the sink faucet, and the Bunsen burner connected to the gas range. Dr. Brunstetter, author of the accompanying description of this ingenious laboratory, is shown examining the clever set-up.

Chemical Laboratory in an Apartment

by BYRON C. BRUNSTETTER

ORDINARILY an apartment would be considered the least desirable of all possible places for the operation of a chemical laboratory. Obviously it is not the best situation for an adolescent in the "boom-bang" stage of chemical evolution, nor for a young chemist whose principal interest is the manufacture of vile odors. But in Mr. Hopkins' hands, his apartment laboratory was a serious workshop on a professional level, unmarred by stains, explosions, or complaints from neighbors. Since there undoubtedly are many thousands of apartment dwell-

ers who would get endless pleasure and profit experimenting in a private laboratory, a description of his workshop should be of general interest.

As the photographs show, his laboratory was in the kitchen and his bedroom in the attractively furnished apartment. The source of heat, a matter of primary concern to chemists, was a Bunsen burner attached to an outlet in the gas stove. For fast filtration, he had a type of water pump which could be locked over the smooth nozzle of a water faucet. The pump was attached by a rubber hose to a filter flask carrying a Buchner funnel.





► IN A CORNER of his bedroom young Hopkins weighed out his chemicals and recorded his experiments. On the wall over his desk is his Roosevelt High School pennant, his certificate of the American Legion school award and the photograph taken at the 1946 Science Talent Search hobby show, picturing him with his chemical exhibit.

The Bunsen burner, flask, ring-stand and other necessary pieces of equipment rested on a plywood board two feet square, placed on one side of the sink. Here too he carried out such operations as refluxing and distillation. For slow evaporation, a watch-glass placed on the warm coils at the back of the refrigerator was adequate.

Sometimes an operation in organic chemistry generates fumes, such as the oxides of nitrogen, which must be eliminated quickly. Mr. Hopkins' technique was simple and direct. He would hold the fuming mixture outside the window, while his mother stood back of him holding an electric fan!

For weighing out ingredients for an organic reaction, Mr. Hopkins used scales, cheap but well-constructed and efficient, costing about ten dollars.

Chemicals and glassware were stored in a steel kitchen cabinet in his bedroom. A small table beside it held the scales and more glassware.

His laboratory was assembled over a period of five years and at current prices represented an investment of approximately seventy-five dollars. There were 15 types of glassware, such as beakers, burettes, condensers, crucibles, graduated cylinders, funnels, evaporating dishes and various kinds of flasks, and a good thermometer. The hardware items were simple and well-chosen: different types of Bunsen burners, clamps, cork-borers, files, ring-stand with suitable clamps, wire gauzes, clay triangles, tripods and test-tube brushes. Then, of course, there was a good working stock of rubber tubing, filter paper and various sizes of stoppers, both cork and rubber.

He had thirty different kinds of in-



► JOHN'S BOOKS have been deposited in the library at Roosevelt High School to form the nucleus of a collection of literature on advanced chemistry and related fields, in memory of him.

organic chemicals. Among them were reagents frequently used by organic chemists: potassium and sodium nitrites (for Mr. Hopkins was specially interested in diazotization reactions), charcoal for decolorizing solutions, metallic sodium (kept under kerosene, of course), anhydrous aluminum chloride, fuming sulfuric and fuming nitric acids, phosphorus penta-chloride and various oxidizing and reducing agents.

He had 22 different kinds of organic chemicals. Among them were solvents such as methyl alcohol, ether, acetone, benzene, carbon tetrachloride and nitrobenzene. Aniline was prominently represented as a source for various syntheses using the diazo reaction.

Other items were chlorosulfonic acid, β -naphthol, p-phenylenediamine and phthalic anhydride.

An adequate library is part of the equipment of every serious chemical laboratory. In this respect Mr. Hopkins was very fortunate for he had available and freely used various Washington libraries such as the Carnegie Public Library, the U. S. Department of Agriculture Library and the Congressional Library. Here he consulted the chemical literature before synthesizing an organic chemical.

At the time of his death he had synthesized over a dozen organic chemicals in his home laboratory, carefully recording the details in his notebook. These projects, of course, were in addition to chemical work he carried out in the laboratories of his high school and college.

His main project, described in his

1946 prize-winning essay, was the use of the diazo reaction in an attempt to make substances which might be useful as synthetic resins and plastics. In other words, he hoped to learn how to "zipper together" small molecules in repeating units to form very large molecules.

This daring project illustrates one of the chief joys of a home laboratory. There the owner is the boss; he can work on what interests him when it interests him, by any method he chooses. There he can dream and have fun in trying to make his dream come true. A further rich dividend is the practical experience gained. Somehow, observations made in one's own laboratory seem to stick in one's mind and, as they accumulate, form a valuable background. Then, too, inspiration comes to busy hands. Often something occurs which suggests a new line of attack or a fresh point of view.

Infra-Red for Drying Chemicals

► MILLIONS of tons of smokeless powder were dried during the war by the use of the invisible infra-red radiation (heat) without a single fire.

The same infra-red ray that the U. S. Army used in its snooper-scopes and sniperscopes to detect night-prowling Japs. Both Germans and Japs used it for short-distance communication where wire or wireless service could not be installed.

Other new applications of infrared in industry were told by Dr. Paul H. Goodell of the Trumbull Electric Manufacturing Company, in a paper before the American Society of Mechanical Engineers. A speeded-up process has been developed by which

complete curing of modern synthetic enamel finishes takes place in about one-fourth of the time currently associated with infra-red heating.

A continuous smokeless powder drier was described by C. E. Silk and H. E. Clark of Western Cartridge Company. Drying is necessary in smokeless powder making.

In operation, the damp powder after mixture is carried through the drier on a wide belt on which it is spread in a thin layer. It passes under banks of infra-red lamps. The moist air forming over it is removed by a constant circulation of air which moves in the opposite direction to the moving belt and its load of powder.

Extract Appears Promising, While Blue Dyes Slow Growth

Immunity To Cancer For Rats

* A CANCER extract that both destroys cancer in rats and makes the animals immune to further cancers is announced by Drs. Margaret R. Lewis, Paul M. Aptekman and Helen Dean King of the Carnegie Institution of Washington in that institution's annual report.

The experiments, made at the Wistar Institute in Philadelphia, are believed to be the first in which such double anti-cancer action has been achieved.

The anti-cancer material was made by grinding up rat tumors, extracting with alcohol and concentrating the extract by distillation. It was then injected repeatedly into tumors that had been implanted in 58 inbred white rats. The grafted tumors came from other rats of the same strain.

In 56 of the 58 rats, the malignant tumors, or cancers, were destroyed and the site of the graft healed with only a slight scar. After one year, 24 of the rats were still free of cancers.

The same kind of tumors, or cancers, were again grafted onto the other 32 of the rats that had been given injections of the tumor extract. More than three-fourths of the animals, 25 to be exact, proved immune to two or three such grafts after the cancer extract injections.

When tumors of this same kind were injected into more than 5,000 rats of the same strain that did not

have the extract injections, every tumor grew and not one regressed.

The extract also protected 60% of injected rats against cancers of a different kind than that from which the extract was made but which afflicted rats of the same strain.

Cancer-Slowing Dye

Penicillin led Dr. Lewis to discovery of a group of dyes, the Nile blues, which slow the growth of the kind of cancer called sarcoma. With Ivor Cormnan she has previously discovered that penicillin slowed the growth of cancer cells on tissue cultures outside the body. The slowing action came from an impurity in the penicillin, not from the mold chemical itself.

The impurity, Dr. Lewis found, was yellow in color, so she tested various pigments found in molds and other plants and also synthetic dyes.

The Nile blues and other chemicals called oxazones were fed to mice bearing grafts of a sarcoma that always grows when grafted onto the strain of mice in which it develops. Every sample of Nile blue and corresponding oxazone stained the tumors a diffuse blue and slowed their growth. Some cancers were held back to one-twentieth the size they ordinarily reach, and others were almost destroyed.

Grafts from the surviving bits of tumor, when transplanted to other mice, grew much more slowly than those from medium-sized tumors.

► AMERICAN newspapers have played a leading role during the past two decades in informing the world about the progress of science in all fields. SCIENCE SERVICE, the institution for the popularization of science and the world's only science syndicate, has provided the day-by-day reporting and background of scientific advances that have made this possible. Among the newspapers that have joined with Science Service in this important public service are:

Birmingham (Ala.) Post
Berkeley (Cal.) Gazette
Pasadena (Cal.) Post
San Francisco (Cal.) News
Denver (Col.) Rocky Mountain News
Bridgeport (Conn.) Post
Hartford (Conn.) Times
New Haven (Conn.) Register
Waterbury (Conn.) Republican
Washington (D. C.) Daily News
Daytona Beach (Fla.) News-Journal
Miami (Fla.) Herald
St. Petersburg (Fla.) Times
Atlanta (Ga.) Journal
Augusta (Ga.) Herald
Chicago (Ill.) Daily News
Chicago (Ill.) Times
Peoria (Ill.) Journal-Transcript
Evansville (Ind.) Press
Indianapolis (Ind.) Times
Covington (Ky.) Post
Lexington (Ky.) Leader
Baltimore (Md.) Evening Sun
Portland (Me.) Express
Boston (Mass.) Globe
Springfield (Mass.) Republican
Ann Arbor (Mich.) News
Bay City (Mich.) Times
Detroit (Mich.) Free Press
Escanaba (Mich.) Daily Press
Flint (Mich.) Journal
Grand Rapids (Mich.) Press
Jackson (Mich.) Citizen-Patriot
Kalamazoo (Mich.) Gazette
Lansing (Mich.) State Journal
Midland (Mich.) News
Muskegon (Mich.) Chronicle
Saginaw (Mich.) News
St. Paul (Minn.)
Dispatch and Pioneer Press
Kansas City (Mo.) Star-Times
St. Louis (Mo.) Globe-Democrat
Nashua (New Hamp.) Telegraph

Hackensack (N. J.)
Bergen Evening Record
Newark (N. J.) *Star-Ledger*
Trenton (N. J.) *Times*
Albuquerque (N. Mex.) Tribune
Brooklyn (N. Y.) *Eagle*
Buffalo (N. Y.) *Evening News*
Jamaica (N. Y.) *L. I. Press*
New York (N. Y.) *Times*
New York (N. Y.) *World-Telegram*
Syracuse (N. Y.) *Post-Standard*
Troy (N. Y.) *Observer-Budget*
Utica (N. Y.) *Observer-Sentinel*
Cincinnati (Ohio) Post
Cleveland (Ohio) Press
Columbus (Ohio) Citizen
Dayton (Ohio) News
Toledo (Ohio) Blade
Oklahoma City (Okla.)
Oklahoman and Times
Pittsburgh (Pa.) Press
Wilkes-Barre (Pa.) *Sunday Independent*
York (Pa.) *Gazette & Daily*
Providence (R. I.) *Sunday Journal*
Anderson (S. C.) *Independent*
Chattanooga (Tenn.) *Times*
Knoxville (Tenn.) *News-Sentinel*
Memphis (Tenn.) *Press-Schimitar*
Beaumont (Texas) *Enterprise*
El Paso (Texas) *Herald-Post*
Ft. Worth (Texas) *Press*
Houston (Texas) *Press*
Beaumont (Texas) *Journal*
Laredo (Texas) *Times*
Salt Lake City (Utah) *Tribune*
Charlottesville (Va.) *Progress*
Harrisonburg (Va.) *News-Record*
Lynchburg (Va.) *Daily Advance*
Norfolk (Va.) *Ledger-Dispatch*
Richmond (Va.) *Times-Dispatch*
Roanoke (Va.) *World-News*
Winchester (Va.) *Star*
Seattle (Wash.) *Times*
Toronto (Canada) *Telegram*
Vancouver (Canada) *Province*

SCIENCE SERVICE



Editorial: Caveman's Comfort—Continued from inside front cover

makes the standard of living. By that term we mean the degree of comfort available to the teeming thousands in our cities. If your house is draughty and inadequately heated, with leaky window frames and roof and a damp cellar, if your clothing is shoddy and the price of food is too high for your income, your standard of living is not up to par. You are obviously not enjoying the level of comfort enjoyed by a savage in a fur sarong, tending the hearth-fire in a dry cave, with a dinner of buffalo steak in the recent past and a haunch of venison hanging in the "deep freeze."

Our dilemma is that we cannot retreat into the past. America recapitulated in 300 years the advance from the primitive to the super-civilized. We have perfected such techniques as the piped-in safe water supply to make possible the degree of congestion in which so many of us live. The near-by spring and the kitchen-midden are sufficient conveniences for the isolated savage, but not for the city dweller. Typhoid fever forced us to protect our water supplies. Malaria and dysentery made us clean up our dump heaps and invent sewage disposal. Typhus taught us to bathe, to use washable clothing and to get rid of insect parasites. Therefore we live longer, and more of us survive.

The resulting increased population is pressing very hard now upon the available living facilities. Houses designed for one family are now regularly sheltering at least two families and often more. Water supplies are becoming inadequate. Coal, oil, gas and electricity are often furnished by monopolies which, shortsightedly, are trying to squeeze speculative profits out of services which have become necessities.

Similarly, the use of antiquated building methods is being enforced by the timid to avoid the necessity of meeting housing problems. These problems have been piling up ever since plumbing and power began to change housing standards to those of a machine for living instead of, as formerly, those adequate for a good barn.

The new materials, whether they remind you of plywood, sheet metal, glass, celluloid or linoleum, are essentially pre-fabricated surfaces, adapted to machine handling. We are no longer limited by the linear dimension of a tree, the breadth of a brick-layer's grasp, the ache of a hod-carrier's back. This is the age of the machine, and there is every reason why houses as well as airplanes, automobiles and tractors can be manufactured. Heat, light, water, power, air-conditioning and refrigeration are the essentials for home-making today. Equipment to provide them is already designed and produced by quantity methods with the economies which such methods provide. Housing for this equipment, large enough for adequate shelter for the family that uses it, and durable enough to last their lifetime, should come off similar assembly lines.

With the techniques and skills we have already available we can get back to the comfort of the caveman, instead of limiting ourselves to building smaller and worse caves.

